

# Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

*June 1999 Vol. 20 No. 6*

- **Making RS-232 Interfaces Work**
- **Three-Axis Chopper, Step Motor Controller for CNC Applications**
- **Switching Voltage Regulator Basics**
- **A Wolf in PIC's Clothing?**
- **Out of Sight High-Frequency Antennas**
- **Switching Power Supply**
- **Optoelectronics**
- **Robotics**
- **Plus Much More ...**

U.S. \$3.50 CANADA \$5.00







# CLONE, TEST OR REPAIR ANY HARD DRIVE

"THE MOST COMPLETE HARD DRIVE WORKSTATION WE'VE SEEN!" BOB ROSENBLOOM, DIGITAL VIDEO, INC.

## DRIVE SERVICE STATION

Copy entire hard drives with ease. Drive duplicators are essential tools for dealers and system builders. Don't spend hours installing and formatting drives. Do it instantly with the Pro. Set up any SCSI or IDE drive with your original software. Connect blank drives to the Pro and press start. You'll copy entire drives faster and more accurately than is possible on any PC. With our combination IDE and SCSI model, you can even copy data between different interfaces. All models include both 2.5" and 3.5" interface adapters. The Pro also supports SCA and Wide SCSI drives.

Choose the Pro, and you'll also have an entire factory drive test and repair system for under \$1000. The Pro gives

**BUY MANUFACTURER DIRECT: \$995**

**408 330-5525**

you the ability to copy, reformat, repair, translate, and test any hard drive. Use the Pro to put any hard drive through its paces. A full factory final test and performance analysis is performed. Complete test and repair reports are sent to any standard printer.

The Pro will also reassign and eliminate drive defects. Here's how it works: First, a precise media analysis system scans the disk for errors. Defects are mapped out, and effectively "erased." The error correcting system then "trains" the drive to permanently avoid defective areas. Data is stored only on the safe

areas of the disk. Capacity is reduced by an insignificant amount, and the drive works flawlessly once again. Get the technology used by major repair shops and data recovery centers. The Pro repairs all disk defects caused by normal wear. Drives with mechanical damage may not be repairable.



**CORPORATE SYSTEMS CENTER**

3310 WOODWARD AVE., SANTA CLARA, CA 95054

[WWW.DRIVEDUPLICATORS.COM](http://WWW.DRIVEDUPLICATORS.COM)

Call today for high volume multi-drive copiers and CD Duplicators  
Sold and intended for backup purposes only. Copyright laws must be observed.



# HSC Electronic Supply

Serving  
Silicon Valley  
since 1964!

...brings you a potpourri of high-tech goodies for the techno-tinkerer!  
For thirty years we have been your source for Silicon Valley exotica!

## Get the Right Touch with ALPS Input Devices!

Get name-brand quality at bargain-basement prices with these premium keyboards and mice -- all are new and have a 90-day HSC warranty. Some quantities limited!

### Alps Premium Keyboard

- ◆ 'AlpsTouch' (tm) Model: MCL-101
- ◆ Premium mechanical keyswitches
- ◆ Audible key clicks
- ◆ Industry-standard 101-key layout
- ◆ IBM AT, PS/2 and 100% compatible

HSC# 17828 **\$14.95**

### Alps PS/2 - Style Keyboard

- ◆ Alps 'WB' series PC compatible keyboard
- ◆ 101 key, Windows layout
- ◆ Small footprint, low profile, lightweight

HSC# 17829 **\$12.50**

### Alps Adjustable Mouse

- ◆ For Macintosh computers
- ◆ The first mouse that adjusts to you!
- ◆ Three programmable buttons!
- ◆ Sleek design for comfort, easy handling
- ◆ Chording -- Program multiple button combinations!
- ◆ Requires Mac O/S 6.04 or later, available ADB port
- ◆ 400 dpi resolution, Made in U.S.A.

HSC# 17827 **\$17.50**

### Alps 2-Button Mouse

- ◆ Two-button type with PS/2 plug
- ◆ Ergonomic shape for comfort, easy handling
- ◆ Ultima Driver software v1.3 diskette included
- ◆ 400 dpi resolution
- ◆ New, OEM package, 90-day warranty

HSC# 17830 **\$3.95**

Other Alps devices in stock...check in the store for other keyboard & mouse deals! Hurry, supplies limited!

## Ultimate Family Tree Deluxe Software

- ◆ Easiest and fastest software for cataloging and completing your family tree!
- ◆ Free professional genealogy family search
- ◆ Access to over 500,000,000 names and sources!
- ◆ Easy step-by-step instructions and tutorials included
- ◆ Lots of charts and reports!

HSC# 80471 **\$9.95**

## Video-hacker Dream!

- ◆ Logitech Videoman Video-conference camera & interface
- ◆ These units were sold with Hewlett Packard S-700 workstations for videoconference capability
- ◆ We do not have technical data, software or manuals
- ◆ All we have is cameras with stand, and SCSI-II interface
- ◆ The camera is on a weighted stand that extends from 13" tall to over 20" tall, and has a stereo microphone
- ◆ Color camera is digital output only (not NTSC) as far as we can tell -- but who knows?
- ◆ Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video input (BNC), and the connector for the camera cable.
- ◆ Note: HP and Logitech will provide no information on these

HSC#17503 **\$39.95**



HSC#17503 **\$39.95**

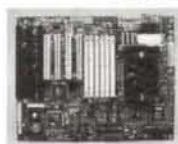
## Superior Motherboards!

High-quality Micronics motherboards for top-level performance! Both boards feature:

- ◆ Built-in Pri. & Sec. Mode4 IDE controller, floppy controller
- ◆ 2 - USB ports at 12Mbps rate, connect as many as 127 devices to host system
- ◆ 2 SIO ports, 1 PIO port, Game/MIDI port, PS/2-style keyboard and mouse connectors
- ◆ Full support for the 'Green PC' specification

- ◆ "DUAL FORTRESS" has dual Intel Slot 1 sockets for Intel Pentium II chip at 233/266/300 MHz (CPU's not included)
- ◆ ATX motherboard has 4 PCI, 2 ISA slots, (one shared)
- ◆ Intel 440FX PCiset, PIIX 3, SMC FDC37C93X Ultra I/O
- ◆ Four 3.3V unbuffered 64-bit DIMM sockets, support for EDO, BEDO, Fast Page Mode (FPM) memory, ECC
- ◆ Yamaha OPL MIDI/sound on board w/ drivers
- ◆ New in box, 90-day warranty, with instruction book, CPU brackets, Win/DOS driver diskettes & cables

HSC#80469 **\$99.00**



- ◆ M6MI "Pentium Pro" ATX motherboard has 4 PCI, 3 ISA slots, Intel 440FX PCiset
- ◆ Comes with tested "Pentium Pro" 150 MHz CPU installed w/ heatsink, fan & VRM module
- ◆ Supports up to 384Mb memory (6 x 72-pin SIMMs)
- ◆ Support for EDO, Fast Page Mode (FPM) memory, ECC
- ◆ New in box, 90-day warranty, with instruction book

HSC#17625 **\$129.00**

## Personal-size Ethernet Hubs!

- ◆ Astro-Link CT-1008D is the simple network solution!
- ◆ Tiny 8-port 10Base-T hub measures 6.75" x 4" x 1.25"
- ◆ Easy to link two hubs together via RJ45 uplink connector
- ◆ Link/Activity LEDs show connection/activity status of each port, power and collision indicators show hub status
- ◆ Aluminum housing to provide excellent heat dissipation and EMI shielding
- ◆ New in box, 90-day warranty, includes AC adaptor, book

HSC#17862 **\$27.50**

## PCMCIA Sound Card!

### Media Vision PCMCIA Sound Card

- ◆ Great for Portables, Laptops with PCMCIA Slot
- ◆ External pod has joystick port, mic. input, line in & line out jacks, volume control.
- ◆ Install software, inst. included.
- ◆ Win 3.x, W95 compatible
- ◆ New in OEM pkg (no box), 90-day HSC warranty
- ◆ We had these before at \$39.95 and they went fast!

HSC#17036 **\$29.95**



## Compaq Docking Bay

- ◆ Compaq docking "Smartstation" for laptop computer (we don't know which!)
- ◆ Has two internal ISA slots
- ◆ SCSI port, network ports, serial, parallel, video, keyboard & mouse ports on back.
- ◆ Used, 90-day warranty

HSC#17713 **\$39.00**



## SCSI Hard Drive Deal!

- ◆ Seagate ST15150N 3.5" half-height drives
- ◆ Industry-standard high-capacity storage, 4.3 gigabytes
- ◆ SCSI - II interface, 1 megabyte buffer
- ◆ Very little used, tested good
- ◆ 8200 RPM, 9ms avg. seek time
- ◆ Non-partitioned, will need to be formatted
- ◆ HSC 30-day warranty

HSC#17908 **\$199.00**

## Rechargeable Battery Buy!

Three types of rechargeable battery for a variety of uses!

Amazing power in a small package! Nickel-Metal Hydride (Ni-MH) batteries have the capacity of Nicads without the "memory" effect. These are factory-new, not pulls!



- ◆ Toshiba 8TH-F5-F1-AIR, 9.6VDC at 600 mAh, measures 4.5" x 1.875" x .25" thick (8 cells in series)
- ◆ Appears to have a thermal fuse for over-current protection

HSC#17871 **\$17.50**

...Or you can choose a NiCad battery pack in a similar form-factor. These are a flat array of cells, like the battery above, with handy solder tabs for connection.

- ◆ Thin NiCad pack, 8.4VDC at 450 mAh, measures 4.5 x 1.875 x .25" thick (7 cells in series)

HSC#17872 **\$12.50**

...Or you may need the power of a lead-acid battery. These are all new batteries with tab terminals. Perfect for hobbies, security systems, battery back-up, garden equipment, etc.

- ◆ TR1.2-12, 12VDC at 1.2 AH, measures 3.75 x 1.875 x 2"

HSC#17197 **\$4.95**

- ◆ TR4-6, 6VDC at 4 AH, measures 2.75 x 1.75 x 4"

HSC#17588 **\$4.95**

- ◆ BAT-0063 (x2), 12VDC at 10AH, 4" x 6" x 4", this is two 6-volt batteries packaged in series by Best Power

HSC#17810 **\$17.50**

## Home Alarm Stuff!

These items are dealer-returned inventory (shelf worn packaging but unused) of home security components that were made by Telco Inc. Mix and match to create your own bargain security system! All items have mounting screws or adhesive pads, instructions, and alarm units have window warning stickers. All parts have 30-day warranty.

- ◆ ST911 Automatic Phone dialer has screw terminals for sensor input, power adapter, and very long phone cord.
- ◆ Instantly contacts up to four pre-selected phone numbers with your own digitally recorded 16 second message.

HSC#17718 Phone Message Dialer **\$27.50**

- ◆ S086N Glass Vibration Sensor Alarm -- self-contained unit detects attempted entry or breakage of fixed or sliding glass windows and doors. Only 2" across!
- ◆ High output 90 db alarm sounds instantly, providing a powerful deterrent to would-be intruders. Self-stick adhesive requires no tools. Alarm battery included.

HSC#17753 Glass Vibration Sensor Alarm **\$2.95**

- ◆ S002M Digital Control Motion Alarm has wall-mount keypad, PIR infrared motion detector with 110° coverage to 60 feet, programmable security code, 10 - 15 second entry delay, extremely loud alarm.
- ◆ Uses 9V battery or AC Adapter (neither included)

HSC#17720 Digital Control Motion Alarm **\$15.00**

- ◆ S008B Digital Control Motion Alarm with Safety Chime has wall-mount keypad, PIR infrared motion detector (same as S002M above) with very loud alarm OR safety chime alert.
- ◆ Uses 9V battery or AC Adapter (neither included)

HSC#17721 Digital Motion Alarm/Chime **\$17.50**

- ◆ S082X Entry Guard Alarm has wall-mount keypad, mag-switch activation (one switch included), programmable security code, 10 - 15 second entry delay, extremely loud alarm or pleasant door chime.
- ◆ Uses 3 AAA batteries (not included)

HSC#17722 Digital Entry Guard Alarm **\$12.50**

## UPS Bargain Bonanza!

No we don't mean from the shipping company, we mean Uninterruptible Power Supplies!

- ◆ TrippLite BCPERS500 has 500VA rating, enough for one personal computer to be shut down properly when the power goes out.
- ◆ Measures 5" x 9.5" x 7" tall, small size fits anywhere!
- ◆ Four surge-protected outlets, circuit breaker on back.
- ◆ Status LED's on front panel.
- ◆ Used, 30-day warranty



HSC#80473 **\$59.00**

- ◆ APC-420 has 420VA rating, enough for one personal computer to be shut down properly when the power goes out, or operated for a short time.
- ◆ Measures 4.75" x 14.5" x 7" tall, handsome appearance!
- ◆ Four surge-protected outlets, circuit breaker on back.
- ◆ Has telco or 10-base-T surge suppression as well!
- ◆ AUI port will output to a network for power alert, shutdown
- ◆ Status LED's on front panel.
- ◆ Used, 30-day warranty



HSC#17906 **\$89.00**

- ◆ PowerWare Prestige has 1000VA rating, enough for two personal computers to be shut down properly when the power goes out.
- ◆ Measures 10" x 15.5" x 5.5" tall, can lay flat or upright.
- ◆ Four surge-protected outlets, circuit breaker on back.
- ◆ Status LED's on front panel.
- ◆ Used, 30-day warranty



HSC#17907 **\$119.00**

## PCI-Bus 56K Modem!

- ◆ Genica PCI-Bus 56K Modem at unheard-of price!
- ◆ Data, FAX, voice, full V.90 compatibility
- ◆ Voice from handset
- ◆ Windows 95/98 or NT only (Not Win 3.1 compatible)
- ◆ Uses latest Lucent chipset, comes with Lucent drivers
- ◆ New retail box, with Trio application software on CD
- ◆ 90-Day Warranty



HSC#17532 **\$39.95**

## External SCSI Drive Cases

- ◆ Bargain case for 5.25" drives, brand new!
- ◆ 7" x 4.5" x 10.5" overall size
- ◆ 50-pin SCSI connectors
- ◆ SCSI ID switch
- ◆ 65W Power supply (lots of power for hard drives, etc.)
- ◆ Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17130 **\$39.95**

- ◆ High quality low profile case for 5.25" drives, brand new!
- ◆ 7" x 2.25" x 11" overall size
- ◆ 50-pin SCSI connectors, RCA Audio connectors
- ◆ SCSI ID switch, termination switch
- ◆ Tiny 12W Power Supply (5VDC @ 1.4A, 12VDC @ .4A, probably only good for CD-ROM's)
- ◆ Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17357 **\$29.95**

# HSC Electronic Supply

Toll Free (Orders Only) 1-800-4 HALTED  
Internet World Wide Web:

3500 Ryder St., Santa Clara, CA 95051

4837 Amber Ln., Sacramento, CA 95841

5681 Redwood Dr., Rohnert Park, CA 94928

(1-800-442-5833)

<http://www.halted.com>

(408) 732-1573

(916) 338-2545

(707) 585-7344

FAX your orders to:

(408) 732-6428



## Visit HSC's Website!

- ◆ Pay us a virtual visit on the World Wide Web!
- ◆ Simply point your browser to <http://www.halted.com>
- ◆ Site is constantly being revised, please visit often!
- ◆ Check out the amazing "Gizmo of the Week" feature!

## HSC Catalog online!

- ◆ That's right, get HSC's catalog on the World-Wide Web!
- ◆ Simply go to [www.halted.com](http://www.halted.com) and follow the big red link.
- ◆ Adobe .PDF files are available for download and viewing.
- ◆ Or drop on by and pick one up...we'd love to see you!

Terms: Some quantities limited, all items subject to prior sale. Minimum order: \$10.00 plus shipping. Orders under \$20.00 subject to \$2.00 handling fee, in addition to shipping. All orders shipped FOB Santa Clara, CA (this means you pay freight!) by UPS Surface (no P.O. Boxes) unless otherwise specified, in which case prevailing carrier rate plus \$5.00 handling fee applies. Prepaid orders that don't include shipping charges will be shipped freight COD. There is a \$5.00 UPS charge added to shipping charges for COD shipments. If you have questions about your order, please call Customer Service at (408) 732-1854 M-F 9AM to 5PM PST.



# SCANTASTIC!



## This is no ordinary PC controlled Receiver



### TRUNKER

Using two Optocom receivers, Trunker software may be used for control channel trunk following of Motorola®. Also use TrunkTrac® with one Optocom for control channel monitoring.



### REACTION TUNE®

Use the popular Scout/Mini Scout/Super Scout to capture and instantly Reaction Tune the Optocom to the frequency captured. Ideal for mobile use and finding unknown frequencies.

The Optocom computer controlled receiver is no ordinary receiver. The Optocom provides solutions to applications that previously required multiple receivers, external decoders, and receiver modifications. Some features of the Optocom have never before been seen on a communications receiver. Ever! With an Optocom, you'll be poised to meet the changing scanning world.

### FEATURES

- Frequency range 25-520, 760-823.995, 849.005-868.995, 894.005-1300MHz (cellular blocked)
- Triple conversion GRE receiver board
- Scan conventional frequencies at 50 channels per second
- Trunk track Motorola and LTR on any frequency band
- Scan conventional and trunked frequencies simultaneously
- Track EDACS systems with additional third party program (E-Trax)\*
- Built-in data slicer for decoding of FSK data
- Discriminator audio input and output
- Reaction Tune with Scout/Mini Scout/Super Scout
- Decode CTCSS, DCS, LTR and DTMF
- Motorola control channel monitoring with Trunker software and two Optocoms\*
- Motorola control channel monitoring with Trunk Trac\*
- Palm Pilot support for frequency and tone display\*
- Store and Scan 100 frequencies for use away from computer
- Supported by other third party scanning programs
- \*Optocom includes: Trakkstar software, Palm Pilot software, Radio Manger for Windows, antenna, serial cable, and power supply



### PALM PILOT™

Interface the popular Palm Pilot™ Connected Organizer to display the frequency being scanned as well as decoding of CTCSS, DCS, and DTMF while in Store and Scan Mode. Software included. Ideal for mobile applications



### TRAKKSTAR®

Using the supplied Trakkstar software the Optocom has the ability to scan conventional frequencies, as well as trunk follow both LTR and Motorola Trunk systems.

*Order Now!*  
**\$499**

**OPTODIRECT 800-327-5912**

**OPTOELECTRONICS®**

5821 NE 14th Avenue • Ft. Lauderdale, FL 33334

Telephone: (954) 771-2050 Fax: (954) 771-2052 Email: sales@optoelectronics.com

Prices and Specifications are subject to change without notice or obligation

Order Online at [www.optoelectronics.com](http://www.optoelectronics.com)

\*Trunker, Trunk Trac, E-Trax, Scout, Computer, and Palm Pilot Connected Organizer not included.



# THREE-AXIS CHOPPER, STEP MOTOR CONTROLLER FOR COMPUTER NUMERICAL CONTROL (CNC) APPLICATIONS — PART 2

This month, we build our three-axis, two-amp driver and do initial check-out so the controls are ready for our machine to be converted to CNC. *Dan Mauch*

## SWITCHING POWER SUPPLY

Find a simple solution to vehicular power-supply problems with this modular switching regulator that provides safe, steady five volts from your vehicle's 12-volt system. *D.P. Roberts*

## THE "OPTO" IN OPTOELECTRONICS — PART 4

The basic operating principles of LEDs and lasers are described in this final installment of the series. *Ray Marston*

## A WOLF IN PIC'S CLOTHING?

Discover a new microprocessor that is compatible with a PIC, but has even more features, not to mention it is low-cost and can run about as fast as a PIC with a 200-MHz clock! *Al Williams*

## OUT OF SIGHT HIGH-FREQUENCY ANTENNAS

Getting onto the high-frequency bands requires big antennas. And, with Technician class operators anticipating their new General class privileges (due to the FCC restructuring of test requirements), manufacturers are ready with the right kinds of equipment. *Gordon West*

## SWITCHING VOLTAGE REGULATOR BASICS — PART 2

Weighing the Options: See how the industry deals with converting 110 VAC into 5 volts, 12 volts into 1,000 volts, and +5 volts into -5 volts; design rules and typical applications are provided. *TJ Byers*

## MAKING RS-232 INTERFACES WORK

Although the RS-232 interface is one of the most common ways of getting information into and out of computers, misunderstanding about the RS-232 have buried users in a profusion of swapped pins, gender changers, breakout boxes, and hydra-head cables. *Gerald Roynance*

## AMATEUR ROBOTICS NOTEBOOK

An update on the Fire Fighting Home Robot Contest, then back to Breadbot. *Robert Nansel*

## ELECTRONICS Q & A

*TJ Byers*

## OPEN CHANNEL

Spectrum analyzers — including one to build. *Joe Carr*

## STAMP APPLICATIONS

Dual digital power supply — Part 2. *Lon Glazner*

## Classified Ad Index

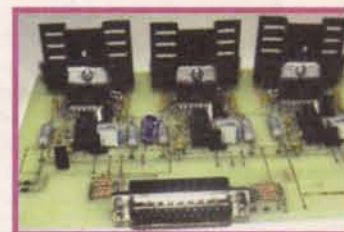
10. Ham Gear for Sale.....39	120. Components.....56
20. Ham Gear Wanted.....39	125. Microcontrollers.....57
30. CB/Scanners.....39	130. Antique Electronics.....57
40. Music & Accessories.....40	135. Aviation Electronics.....57
50. Computer Hardware.....40	140. Publications.....58
60. Computer Software.....41	145. Robotics.....58
70. Computer Equip. Wanted.....41	150. Plans/Kits/Schematics.....58
80. Test Equipment.....42	160. Misc. Electronics For Sale.....60
85. Security.....43	170. Misc. Electronics Wanted.....60
90. Satellite Equipment.....44	175. BBS & Online Services.....62
95. Military Surplus Electronics.....45	180. Education.....62
100. Audio/Video/Laser.....45	190. Business Opportunities.....62
110. Cable TV.....46	200. Repairs/Services.....62
115. Telephone/Fax.....56	

## Departments

Advertiser's Index ... 68
Classified Ad Info ... 68
Dealer Directory ... 32
Events Calendar ... 17
New Product News ... 97
News Bytes ... 10
NV AdMart ... 73-75
NV Bookstore ... 9
Prize Drawing ... 54
Reader Feedback ... 10
Tech Forum ... 66

**NUTS & VOLTS MAGAZINE IS PUBLISHED MONTHLY FOR \$19.00 PER YEAR BY T&L PUBLICATIONS, INC., 430 PRINCELAND COURT, CORONA, CA. POSTMASTER: SEND ADDRESS CHANGES TO NUTS & VOLTS MAGAZINE, 430 PRINCELAND COURT, CORONA, CA 91719.**

**VOLUME 20  
NO. 6  
JUNE 1999**



6

22

25

47

51

76

91

70

34

12

86

Published Monthly By  
**T & L Publications, Inc.**  
430 Princland Court  
Corona, CA 91719  
(909) 371-8497  
FAX (909) 371-3052

**E-Mail**  
editor@nutsvolts.com  
**URL**  
http://www.nutsvolts.com

**Subscription  
Order ONLY Line**  
1-800-783-4624

**PUBLISHER**  
Jack Lemieux N6ZTD

**EDITOR**  
Larry Lemieux KD6UWV

**MANAGING EDITOR**  
Robin Lemieux KD6UWS

**ON-THE-ROAD EXHIBIT  
COORDINATOR**  
Audrey Lemieux N6VXW

**SUBSCRIPTIONS**  
Abby Madain

**CLASSIFIED ADS**  
Natalie Sigafus

Copyright 1999  
by  
**T & L Publications, Inc.**  
All Rights Reserved

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. Nuts & Volts Magazine assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in Nuts & Volts. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in Nuts & Volts. Please send all subscription orders, correspondence, UPS, overnight mail, and artwork to: 430 Princland Court, Corona, 91719.



Several years ago, I designed an L/R (Inductance/Resistance) step motor driver for various CNC machines that I had built. After a while, I found that I wanted more speed from the stepper motors. You can increase the speed of a stepper motor by increasing the motor supply voltage to several times the rated voltage. This allows the coils to charge faster so that more speed can be attained.

The problem with L/R type step motor drivers is that if you were, for example, to run a 5-volt, 1-amp motor from a 24V power supply and your L/R driver

provides the correct phase sequences for the full-step, half-step, or wave-step modes and sends control signals to the L298 Dual H-Bridge. Additionally, the L297 has an onboard PWM chopper that provides switch-mode current control of the windings. The L298 can be used as a 2 amp stepper motor driver and has high-noise immunity. The L297, together with the L298 and a few other components, provides a complete bipolar step motor controller.

Since there are no chopper stepper motor controller kits on the market, I decided to design and build one. This circuit has proven to be a very low-cost solution to running stepper motors at higher than rated voltages.

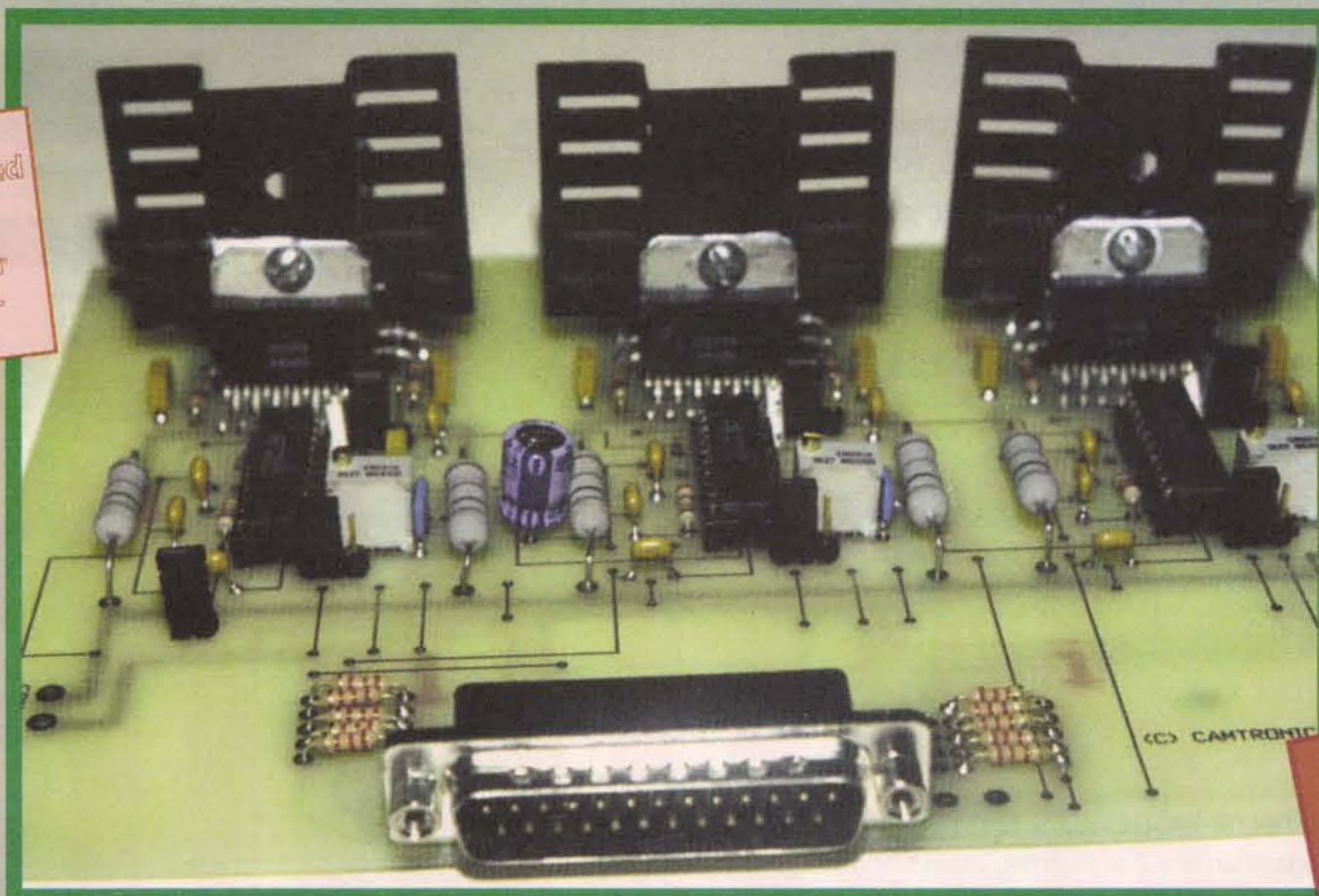
The best part of the L297 and L298 combina-

3. Insert R1, R15, R13 (10K) into the locations shown. Solder in place.

4. Insert R21-R30 (2.2K) into PC board at the locations shown. Solder and clip excess leads.

5. Note the diode orientation on the top layer overlay. There are 24 diodes. Bend the leads of 12 diodes for a .5" lead spacing. Bend 12 diodes for a .55" lead spacing. Insert D1-D24 diodes ensuring that the cathode on the diode is properly oriented as shown in the top layer pictorial. These are a tight fit. Clip the leads about 3/16" long on the bottom of board. Start soldering from one side of the board working to the other ensuring the diodes stay in posi-

The assembled three-axis chopper, step motor controller.



Part  
2

## Three-Axis Chopper, Step Motor Controller for Computer Numerical Control (CNC) Applications

was only rated at 1.25 amp per phase, you would burn out your driver. Thus, a current limiting resistor in series with the motor center taps would be required.

$$R_w = [(V_s - V_d) - V_m] \cdot I_m$$

R = is the wattage of the power resistor.

V<sub>s</sub> is the voltage of the power supply.

V<sub>d</sub> is the voltage drop across the output transistors.

V<sub>m</sub> is the voltage rating of the stepper motor.

I<sub>m</sub> is the current rating of the stepper motor.

Thus, in the above example, an 18-watt resistor would be required for each center tap on the motor. If you have three motors, you would be dissipating quite a bit of power into the power resistors. On the other hand, a bipolar, Pulse Width Modulated (PWM) chopper driver would more efficiently operate a stepper motor at higher than rated voltages.

Some time ago, Karl Lunt of the Seattle Robotics Society and Clay Timmons on the Internet news group comp.robotics.misc discussed the SGS-Thompson L297 (Bipolar stepper motor controller) and the L298 (Dual 2 amp H-Bridge) combination as an efficient stepper motor controller and driver.

The data sheets for the above chips provide a good explanation of the operation of each chip. In short, the L297 takes step and direction signals and

tion is that they work well with many of the low-cost CNC software programs. I particularly like Desknc for Dos see [www.desknc.com](http://www.desknc.com) for a working demo copy. However, for our testing, we will use Dancam which is available for download at [www.metalworking.com](http://www.metalworking.com).

It is now time to build our three-axis, 2 amp driver, so we will have the controls ready for our machine that we will convert to CNC in a future article.

### ASSEMBLY

Begin by reviewing the schematic and the circuit board layout illustrations. You may take the top overlay and place it directly over the top layer illustrations for finding any component that is not readily apparent. Note that all components are installed on the top of the board. To facilitate construction of this controller, a double-sided, plated-through PC board and a kit with all the parts is available from the source listed at the end of this article.

1. Insert snubber resistors R5, R7, R8, R9, R16, R17 (10 ohm 1/4 watt) into the board at the locations shown in the top overlay and solder. These pads are close to the adjacent diodes. Inspect after soldering to ensure there are no solder bridges.

2. Insert R3 (22K 1/4 watt). Bend for a .6" lead spacing. Solder in place.

tion.

6. Bend a scrap resistor lead into a U bend and insert it into the PC boards as a jumper for A2 and A3. Solder in place. Do not install a jumper in A1. There is an oscillator on the X-axis and it synchronizes the Y and the Z axis by connecting pins 1 of U1, U2, and U3 together. The oscillators on U3 and U4 must be grounded via this jumper in A2 and in A3 in order to function properly.

7. Insert U1-U3 20-pin DIP sockets with the notch facing U4-U6 and solder in place.

8. Insert R4, R6, R10, R11, R18, and R19 into the circuit board (.5 ohm 2-watt resistor). Solder and clip excess.

9. Insert C1, C15, and C22 (.22 uF ceramic capacitors).

10. Insert and solder C2 (.0033 uF) into the PC board. Solder and clip the excess leads. Ensure the lead does not short again the trace by pin 20.

11. Insert ceramic capacitors C7, C8, C9, C10, C16, C17 (.022 uF) into circuit board where shown. Solder and clip the leads.

12. Insert C3, C4, C5, C11, C13, C14, C18, C20, and C21 (.1 uF) into the PC board at the locations shown. Solder and clip the leads.

13. Insert C24, C25, C26, C27, C28, and C29 (681 pF) into the PC board and solder. Clip the excess lead.

14. Insert R2, R12, R14 (10K) RADIALLY into



the PC board at the locations shown in the overlay drawing. The body should be next to pin 13 of the L298 and a piece of insulation placed over the exposed lead. Solder in place and clip excess lead.

**15.** Insert Vr1, Vr2, and Vr3 (1K trim pots) with the adjusting screw next to pin 14 of the 20-pin sockets. Solder and clip the excess lead.

**16.** Insert J1, J2, and J3 (three-pin SIP) into PC board and solder. Install a jumper on the two pins closest to the 10K resistor (half-step mode).

**17.** Install J4, J5, and J6 (three-pin SIP) into board and solder at locations shown. Install a jumper on the two pins next to the 20-pin DIP socket for J4, J5, and J6.

**18.** Insert P1 (DB25 connector) into the board and solder in place.

**19.** Install C6, C19, and C12 (470 uF electrolytic capacitor) as shown. Solder and clip the leads. Be sure the negative side of the caps line up with the GRD trace.

**20.** Insert C23 (100 uF electrolytic capacitor) into the circuit board. Ensure that the negative on the capacitor is oriented to connect with the ground trace.

**21.** Insert J7 (two-pin) header into the circuit board and solder. Do not install a jumper over the pins.

**22.** Insert U4-U6 into the circuit board using the overlay drawing for a guide. Solder the 15 pins. Install heatsinks on U4-U6 using a light coat of heatsink compound between U4-U6 and the heatsinks.

**23.** Insert the 18-gauge motor wires into the top

or from the bottom (user's preference) on the board for each motor connection, i.e., phase a, A, b, B. Use a 12" length of red wire for phase "a." Use a 12" yellow wire for phase "A." Use a 12" orange wire for phase "b." Use a 12" green wire for phase "B." Ensure no loose strands are shorting against the diode leads. Solder the connections. Secure with a tie wrap as close to the 470 uF caps as possible. The connector pins for the motor end should not be installed until the controller is placed in a case and the leads should be trimmed to length for a neat installation. Then crimp and solder the 12 (18-gauge) female pins to the motor leads. Insert the leads into the Molex 6 conductor male connector. 1=red=phase a, 2=no connection, 3=yellow=phase A, 4=orange=b, 5=no connection, 6=green=phase B. Make sure to connect the correct wire with the correct pin hole location. The pin hole numbers are on the back end of the connector. A standard configuration is phase a=1, phase A=3, phase b=4, and phase B=6 holes 2 and 4 are not used.

**24.** Insert 22 gauge, two white wires, two yellow, an orange, and a blue wire into the circuit board at the locations shown in the pictorial next to the DB25 connector. Solder and secure with a tie wrap as close to the board as possible. Do not put the female pins on the other end until the unit is installed in a case. Then trim the leads to suit, crimp and solder the female pins, and insert into the 3 and 4 pin receptacles. One white wire (common) goes to pin 1 of the pin circuit female connector. The blue wire goes to

A double sided printed circuit board is available for \$25.00 +\$4.00 S/H from the source below listed.

A complete controller kit with PC board, software, all wires and components is available for \$145.00 +\$9.00 S/H from Camtronics, Inc.

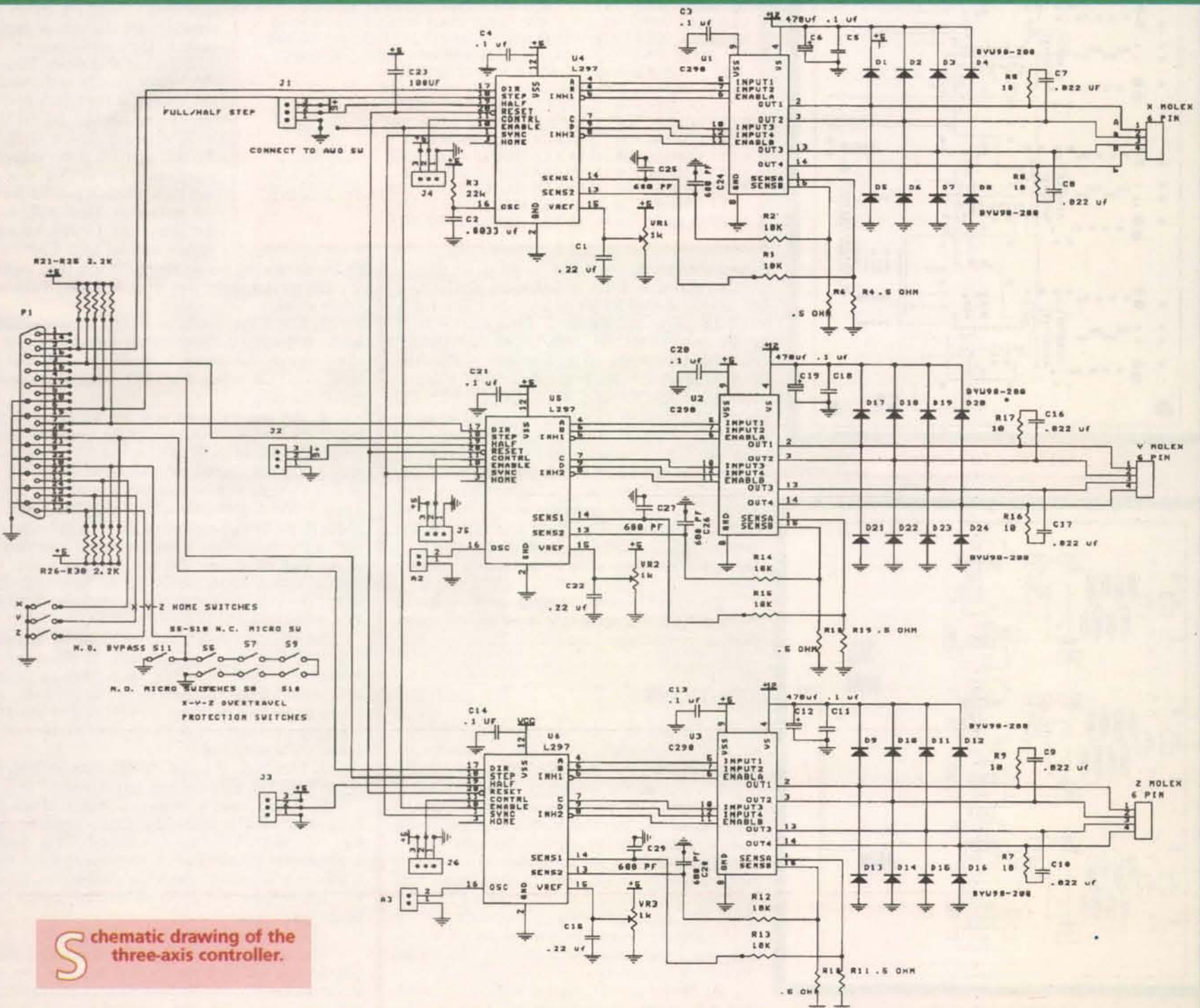
**Camtronics, Inc**  
18230 130th Pl. N.E.  
Bothell, WA 98011-3118

**SOURCE**

You may contact Dan Mauch at dmauch@seanet.com or visit his web page at www.seanet.com/~dmauch

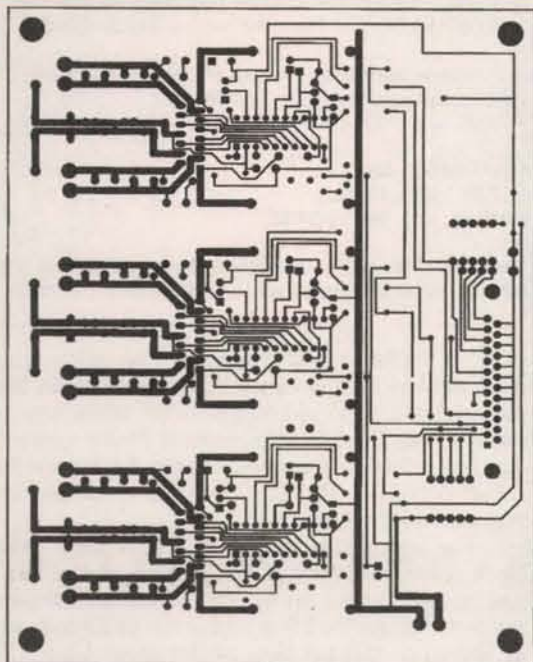
pin 2 of the four-circuit connector. The yellow wire by the blue wire on the circuit board goes to pin 3 and the orange wire to pin 4. The other white wire connects to pin 3 of the three-circuit Molex connector. The last yellow wire connects to pin 1 (>) of the three circuit connector. Pin 2 is not used (1=yellow, 2=no connection, 3=white).

The logic power leads are 18", 18-gauge red and black wires, respectively. Solder one end of the red wire to the +5 pad on the circuit board as shown in the pictorial and the black lead at the GRD connection as shown on the top layer of the circuit board. Trim the wires to suit your installation. Then crimp and solder male 18-gauge pins onto the red and black wires. Insert the red wire into the two-circuit Molex connector (1=red, 2=black) at the hole by the orientation (>) notch of the connector. The black wire is inserted into

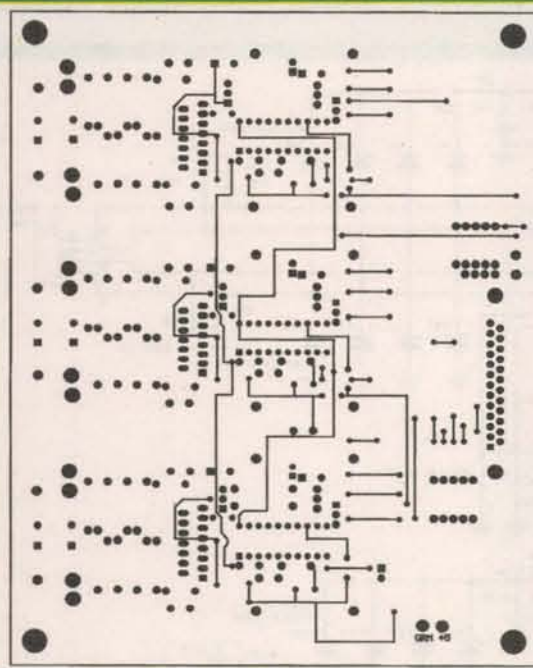


**S**chematic drawing of the three-axis controller.

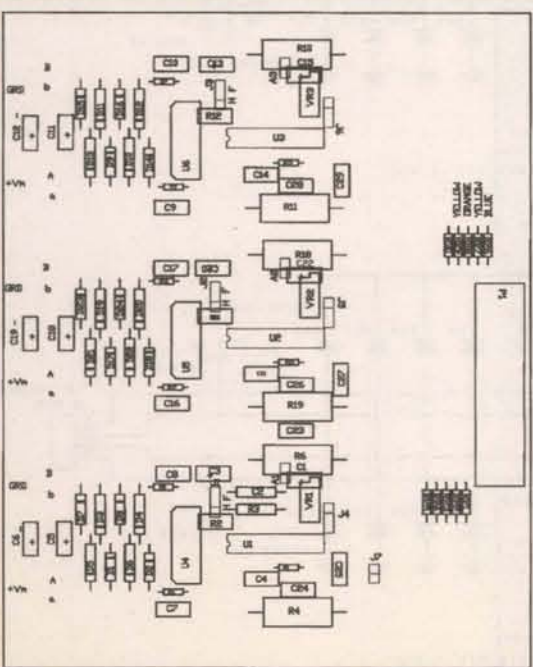




L298N&V BOTTOM LAYER



L298N&V TOP LAYER



L298N&V TOP OVERLAY

Note all resistors are 1/4 watt unless otherwise noted.

DESIGNATOR	COMMENT	PATTERN
A1	WIRE JUMPER	SIP2
A2, A3	WIRE JUMPER	SIP2
C1, C15, C22	.22 uF 50V CERAMIC	RADO.2
C2	.0033 uF 50V	RADO.2
C3, C4, C5, C11, C13, C14, C18, C20, C21	.1 uF CERAMIC 50V	RADO.2
C6, C12, C19	.1 uF CERAMIC 50V	RADO.2
C7, C8, C9, C10, C16, C17	470 uF 50V	RADO.2
C23	.022 uF CERAMIC	RADO.2
C24, C25, C26, C27, C28	100 uF 35 V	RADO.2
C29	680 pF	RADO.2
D1-D24, J1-J6, J7, P1,	680 pF	RADO.2
	BYW98-200 OR EQUAL	AXIAL.5
	3 PIN HEADER	SIP3
	2 PIN HEADER	SIP2
	DB25 RIGHT ANGLE MALE CON.	DB25RA/M
R1, R2, R12, R13, R14, R15	10K	AXIAL.3
R3,	22K	AXIAL.3
R4, R6, R10, R11, R18, R19	.5 OHM 2 WATT	AXIAL.6
R5, R7, R8, R9, R16, R17, R21-R30	10 OHM	AXIAL.3
U1-U3	2.2K	AXIAL.3
U4-U6	L297	20 PIN DIP
VR1-VR3	L298N	MULTIWATT 15
SOCKETS (3)	1K TRIM POT	SIP3
PC BOARD	IC SOCKETS	20 PIN DIP
HEATSINKS (3)	PCB	
JUMPERS (7)	THM 6072	
18 GAUGE WIRE (12)	J1-J7 SHORTING JUMPERS	
18 GAUGE WIRE (3)	MOTOR WIRES (12 INCHES)	
18 GAUGE WIRE (3)	BLACK Vm GROUND (18 INCHES)	
18 GAUGE WIRE (1)	RED Vm + 2VDC (18 INCHES)	
18 GAUGE WIRE (1)	RED +5VDC LOGIC POWER (12 INCHES)	
22 GAUGE WIRE (6)	BLACK GROUND FOR LOGIC (12 INCHES)	
18-22 GAUGE PINS (26)	HOME/OVERTRAVEL PROT. SWITCHES	
18-22 GAUGE PINS (26)	MALE PINS 02-09-2118	
6 CKT CONNECTORS (3)	FEMALE PINS 02-09-1119	
6 CKT CONNECTORS (3)	MOLEX MALE 03-09-1061	
4 CKT CONNECTOR (1)	MOLEX FEMALE 03-06-2061	
4 CKT CONNECTOR (1)	MOLEX MALE 03-09-1041	
4 CKT CONNECTOR (1)	MOLEX FEMALE 03-09-2041	
3 CKT CONNECTOR (1)	MOLEX MALE 03-09-1032	
3 CKT CONNECTOR (1)	MOLEX FEMALE 03-09-2031	
2 CKT CONNECTOR (4)	MOLEX MALE 03-09-1027	
2 CKT CONNECTOR (4)	MOLEX FEMALE 03-09-2021	

## BILL OF MATERIAL

the remaining hole.

The power leads for each axis are similar. Use 18" length of red, 18-gauge wire for +Vm and a black, 18-gauge wire for the GND. leads. Caution: EACH AXIS MUST HAVE A SEPARATE GROUND LEAD ALL THE WAY BACK TO THE POWER SUPPLY OR THE UNIT MAY CAUSE THE MOTORS TO MISS-STEP. DON'T TRY TO ELIMINATE THESE LEADS. Solder the wires to the circuit board as shown in the pictorial. The wires should be trimmed to length to suit the installation. Crimp and solder a male pin onto each wire. Insert the red wire into the two-pin Molex connector. The red lead goes in the hole by the orientation (>) notch. The black lead goes to the remaining hole. Mark these motor power leads so you never mix them with the 5-volt logic connectors.

25. Clean the board and inspect it using a 5-X magnifying lens to ensure there are no solder bridges or unsoldered terminals. Correct as necessary.

## CAUTIONS

1. Be sure to mount the three-axis controller on insulated standoff. One of the mounting pads is close to the Vm connection and could cause a short to ground if a conducting standoff is used. Alternatively, you may scrape off the mounting pad copper foil (top and bottom and inside the hole) and eliminate the problem that way.

2. Never boot the computer with the controller powered up and ready to run. Always turn on your computer first and move to the CNC program first before powering up the controller. As your computer boots, the parallel port is initialized and could cause the motors to step in an uncontrolled manner.

3. Never use a computer with the parallel that is built into the motherboard. If you fry the parallel port on this type of computer, it could be

very expensive to repair. Always use an old AT 286-12 to a 486-66 computer with separate parallel ports on an I/O board. They only cost about \$20.00 to replace. This warning is only given because we can not be sure of the user's circumstances. We have never burnt out a parallel port, but if you have a computer that has business records or is an expensive computer, then use it at your own risk while testing.

## TESTING

Do not connect to your parallel port at this time. Do not install U1-U3 at this time.

1. Using an ohmmeter, verify there is no short circuit between +12VDC and ground on each axis. Similarly, check between +5VDC and ground for a short.

2. Switch the meter to read voltage. Connect a 5VDC power supply to the +5VDC connection and ground. (The controller was designed to use a standard AT style PC power supply rated at 200 watt. These are cheap and work well for low voltage applications.) Do not connect the +12VDC at this time. Turn on the power supply and measure the voltage at the DB25 connector. There should be 5 VDC  $\pm$  .3V at pins 2, 3, 4, 6, 7, 8, 10, 11, 12, and 13. If the voltage is significantly higher than this you can burn out your parallel port. If the voltage is significantly lower (i.e., less than 4 volts), improper signals may be sent. Correct the

problem with the power supply. If you read voltages at some but not all the pins identified, then check your solder joints.

3. Check that you have +5 at the corresponding leads on the X-Y-Z home switch connector using the white wire as the common. Similarly, verify that you have +5 on the yellow lead of the over travel protection connector.

4. Set the reference voltages for U1, U2, and U3. With +5 volts connected to the controller board, adjust VR1 to obtain .5 VDC on pin 15 of the socket for U1. Do not exceed +1V. The Vref divided by the Rs (.5 ohm resistor determines the current output. Thus, a .5VDC reference voltage will yield 1 amp per phase in the two phases on mode. The H bridge cannot handle more than 1 ampere unless a cooling fan is provided. Maximum Vref is 1 VDC for a two amp current rating. REMEMBER TO RESET THE REFERENCE VOLTAGE USING Vr1-Vr3 WHENEVER YOU CHANGE POWER SUPPLIES.

Set reference voltage on pin 15 on U2 and using Vr2, and U3 using Vr3, similarly. If different rated motors are used, then set each variable resistor accordingly. If the voltage will not set correctly, look for solder bridges or opens on VR1 and on pin 15 of U1. Check for opens near J4, J5, and J6. Shut off the power when completed.

5. Insert U1, U2, and U3 into their sockets. The notch faces U4, U5, and U6, respectively.

6. If you have a frequency meter, check that there is an 18 kHz to 20 kHz synchronization signal on pin 1 of U1-U3. Do not proceed if this signal is less than the stated value or not present. If the signal is absent or incorrect, check the oscillator circuit with the 22K resistor and 3300 pF cap for correct positioning or shorts.

This concludes the assembly and initial check-out. In the next article, we will connect the controller to the PC, the stepper motors, configure the software, and test the controller and stepper motors. **NV**



# Get *Hot Deals* On Great Electronic Titles through the *Nuts & Volts* Bookstore

As a paid subscriber to *Nuts & Volts*, you'll receive a 10% discount off the listed price shown here!!



**\$34.95**

"Programming and Customizing BASIC Stamp Computers" by S. Edwards

Build smart electronics projects with the inexpensive, simple-to-use, surprisingly powerful BASIC Stamp.



**\$44.95**

"Handbook of Radio and Wireless Technology" by S. Gibilisco

A comprehensive compendium on the entire field of radio and wireless technology.



**\$39.95**

"Encyclopedia of Electronic Circuits" by R. Graff

An extensive library of 1,000 circuits from the bestselling, six-volume "Encyclopedia of Electronic Circuits."



**\$54.95**

"Handbook of Microcontrollers" by M. Predko

This much-needed reference is the first to cover all the most common types of eight bit microcontrollers.



**\$34.95**

"Electronic Troubleshooting" by D. Tormel and N. Widmer

Troubleshoot and repair any type of electronics with this comprehensive guide.



**\$39.95**

"Programming and Customizing the 8051 Microcontroller" by M. Predko

This tutorial/disk package details the features of the 8051 and demonstrates how to use these embedded chips to access and control many different devices.



**\$39.95**

"Circuit Troubleshooting Handbook" by J. Lenk

This handbook gives full descriptions of the operation of important circuits, and how each circuit's characteristics may figure in its failure or poor performance.



**\$24.95**

"How Electronic Things Work... and What to Do When They Don't" by R. Goodman

Never again be flummoxed, flustered, or taken for a ride by a piece of electronic equipment with this fully illustrated, simple-to-use guide.

## Other Available Titles ...

"Practical Antenna Handbook" by J. Carr **\$39.95**

"Secrets of RF Circuit Design" by J. Carr **\$29.95**

"The Illustrated Dictionary of Electronics" by S. Gibilisco **\$39.95**

"TAB Encyclopedia of Electronics for Technicians and Hobbyists" by S. Gibilisco **\$69.50** (Hard Cover)

"The Robot Builder's Bonanza" by G. McComb **\$18.95**

"Programming and Customizing the PIC Microcontroller" by M. Predko **\$34.95**

"How Radio Signals Work" by J. Sinclair **\$24.95**

"Making Printed Circuit Boards" by J.L. Axelson **\$22.95**

"How to Read Electronic Circuit Diagrams" by R.M. & Lawrence Brown **\$19.95**

"Build Your Own Test Equipment" by H.L. Davidson **\$22.95**

"Radio Receiver Projects You Can Build" by H.L. Davidson **\$21.95**

"Troubleshooting and Repairing Consumer Electronics Without a Schematic" by H.L. Davidson **\$24.95**

"Amateur Radio Encyclopedia" by S. Gibilisco **\$29.95**

"Basic Electronics Theory" by D.T. Horn **\$26.95**

"Ready-to-Build Telephone Enhancements" by D.T. Horn **\$17.95**

"The Benchtop Electronics Handbook: 260 Most Common Popular Electronics" by V. Veley **\$65.00** (Cloth Cover)

**Build your electronics library at a price you can afford!!  
Order now!!**

BOOKS PUBLISHED BY MCGRAW HILL

**Call 1-800-783-4624 today!**

**WE ACCEPT VISA AND MASTERCARD**

Send check or money order to Nuts & Volts, 430 Princeland Court, Corona, CA 91719. Include a complete shipping address (no P.O. Boxes, please). Shipping & handling \$4.50. CA residents add 7.75% sales tax. Or, call our toll-free order-only line at 1-800-783-4624 and use your MasterCard or Visa. **ALL ORDERS MUST BE PREPAID.**



# reader FeedBack

## Dear Nuts & Volts:

I would like to comment on the Tech Forum answer published for question #3996 Mar. '99. When a polarized electrolytic is reverse-biased, its leakage resistance drops rapidly. So, when two of them are connected back-to-back to make a non-polarized capacitor and, a voltage is applied to the series pair, nearly all of the voltage will appear across the forward-biased capacitor. This means the voltage rating of each capacitor must be as great as the maximum applied voltage. To create a 5uF 300V non-polarized capacitor, you should connect two regular 10uF 300V electrolytics back-to-back.

Bob E. Baker, Carmichael, CA

## Dear Nuts & Volts:

I was just browsing a complimentary copy of *Nuts & Volts* and I was bothered enough by the answer to #3996, Mar. '99 in the Apr. '99 issue that I had to notify you immediately of a dangerous answer that was given.

The answer highlights an example of connecting two polar electrolytics back-to-back. The answer says the two 150 volt, 10uF caps in series will be equivalent to a 5uF at 300 volts. This is absolutely wrong. The reason a polarized capacitor is polarized is that it must not be operated with any significant reverse voltage. This hook-up just described requires the capacitor to accept the full 150 volts in reverse!

If you try this, the forward capacitor will be forced to take most of the voltage because the reversed capacitor is very leaky. The voltage across capacitors does not divide according to capacitor value just because they are there.

Other important factors always contribute to the voltage division. In this case, the capacitor reverse leakage is far greater than any other factor. The result is that the 300 volts will at first divide such that the capacitor in normal polarity will be forced to excessive voltage drop. This will lead to excess forward leakage to match the reverse leakage of the other series capacitor. Then both caps will heat up due to this excess current flow and they will ultimately fail in what might be a dangerous explosion much like a firecracker.

Using two caps to create a non-polar cap has always been questionable at best. The devices made for this application at least have the manufacturer thinking about how they are applied and used. One is always better off to use the proper component within its ratings.

Mouser carries non-polar and bi-polar caps in addition to the other suppliers mentioned. With one style of non-polar caps, Mouser's catalog cautions that it is for circuits that are "sometimes reversed or to which short duration AC is impressed." By the way, the acronym NPO normally refers to zero temperature coefficient ceramic capacitor, not to Non-Polar Electrolytic (maybe NPE).

I hope this answer will correct an unsafe application of electrolytic capacitors. There is a lot more to capacitors than just the volts and capacitance. Many caps are misapplied leading to short life or sometimes disaster. They can blow up like a small bomb in the wrong circumstances.

Bob Hillman, Big Bend, WI

## Dear Nuts & Volts:

The answer provided by Ken Simmons to the question of NP capacitors (#3996), ignores a very important factor. Although ordinary capacitors connected in series are equivalent to a single cap, as stated, polarized electrolytics are different in that they behave something like a short circuit when a reverse polarity voltage is applied.

In an audio speaker application, they will be reversed-biased during portions of the signal. To approximate a 5uF NP value, connect two 5uF polarized units in series-buck, as shown in the letter.

By the way, I understand that NP caps even for motor start applications are fabricated from two polarized units.

Phillip Milks, via Internet

## Dear Nuts & Volts:

Your Jan. '99 issue had an excellent article about the PIC-ICE II, In Circuit Emulator for PIC16 microcontrollers. I would like to make your readers aware of another reason-

ably priced unit they may wish to consider. Zilog makes a line of microcontrollers similar to the PIC16, although not quite as extensive, and only available as OTPs.

The Z86E04 will fit in a board designed for a PIC with minimal changes. They sell the Z86CCP01ZEM, an in-circuit emulator and programmer for the OTP chips, for under \$100.00. To use the 28 and 40 pin versions requires an accessory kit for another \$90.00 that adds 28 and 40 pin ZIF sockets for programming, and 28 and 40 pin target cables for emulation. The included developer studio integrates the editor, assembler, and debugger under one interface as does the PIC-ICE. The most notable difference is the speed, the Zilog emulator runs at full system speed.

The crystal and capacitors on the emulator PCB are pluggable, so the crystal from the final circuit can be used on the emulator if timing is really critical.

Tom Wyckoff, via Internet

## Dear Nuts & Volts:

In the Jan. '99 issue, Mr. Henry Van Zee asked for a circuit to light LEDs for input frequencies of 60 and 62 Hz. One reader suggested using two 567 tone decoder ICs. While this approach is sound and will work as requested, it seems that what Mr. Zee is trying to do is to simulate the old vibrating reed frequency meters used to monitor the output of motor-driven portable generators. These meters used 8-10 steel reeds of varying resonant frequency which were driven by a coil coupled to the output of the generator. In operation, all of the reeds wiggled slightly, however, the reed whose resonant frequency was closest to the driving frequency of the coil vibrated the most.

By observing which reed was vibrating most strongly, the generator's governor could be set to keep the output frequency at a nominal 60 or 400 Hz. This device can be easily and cheaply simulated with a simple two-IC circuit.

Design a phase locked loop based on an LM566 with a center frequency of 60 Hz and a bandwidth of about  $\pm 4$  Hz. Connect the generator or other AC source (isolated and attenuated as required) to the input of the PLL. Connect the error signal of the PLL to the input of a bargraph display IC which drives an array of 8-10 LEDs.

The PLL compares the external signal to its own internal reference frequency which is generated by a voltage controlled oscillator (VCO).

As the input frequency deviates from the design or center frequency of 60 Hz, the feedback system within the PLL will generate an error signal which causes the VCO frequency to shift. This causes the VCO to track the input frequency exactly. Since the error signal is proportional to the deviation from the PLL center frequency, a bargraph display connected to the VCO control signal indicates deviations from the center frequency.

Through proper design of the PLL and selection of the correct calibration resistors, the bargraph display can be made to change in response to 1 Hz changes in the input frequency.

Dave Sarraf, via Internet

## Dear Nuts & Volts:

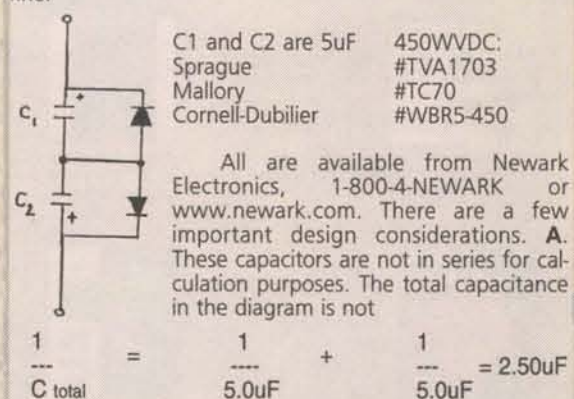
Mr. Simmon's solution to Tech Form question #3996 about non-polarized capacitors raises some safety concerns. The two capacitors are "in series" in appearance only. If the combination sees an AC signal with no DC component (or a small one), then each capacitor experiences a reverse-bias on one-half cycle. Reverse-bias and sufficient ripple current can cause either capacitor to over-heat and possibly explode. (I speak from experience.)

Mr. Simmon's solution works fine for a quick test or breadboard (exercise caution, check the waveform with a scope, and wear safety goggles), but Mr. Broussard's original application in #3996 is to replace a capacitor in an ARC-5 receiver. Back-to-back capacitors is not a safe way to go in that application. Also, if the back-to-back combo was connected to a capacitance bridge, it would measure 7-10uF. Again, the capacitors are not electrically in series and the value depends on when each capacitor reverse biases and conducts (it can vary widely).

Finally, the part Mr. Broussard needs is not available from MCM Electronics or Digi-Key.

## CORRECTED ANSWER TO #3996

A non-polarized capacitor (also called a "bipolar" cap) has no positive or negative terminal. A non-polarized capacitor yields the benefits of an electrolytic: high capacity per given volume, moderate voltage, low ESR, and high surge current capability in non-DC applications. It's fairly common in TV and radio circuits and if you can't find an exact replacement, the circuit below will do the job just fine.



It's just 5.0uF. Also, the total voltage capacity is not 900 volts. It's just 450 volts. These capacitors are not in series. The diodes simply put one capacitor into the circuit and then the other.

B. The diodes and the capacitors might have to carry some surprisingly high currents. Good examples are the power stage of an amplifier or the vertical deflection circuit of a television. Be sure to check the "ripple current rating" and "core temperature" for the capacitors and the "forward current rating" for the diodes. Also the diodes must be 400V PIV minimum. If the old capacitor burned out, consider designing 20%-50% more current carrying capacity into the replacement.

C. Pay attention to safe design practices. If a diode "opens" due to high current or a bad solder joint, the associated capacitor can explode (just like any other reversed-biased electrolytic).

Bob Miller, Trenton, NJ

# Newsbytes

## ObjectARX multimedia CD-ROM Course teaches how to program AutoCAD in C++

Ransen Software announces Ransen's ObjectARX Course, a unique multimedia CD-ROM that teaches you how to program AutoCAD 2000 and AutoCAD 14 in C++. This self-paced course consists of 20 chapters, a help file, and many complete source code examples. The course takes you step-by-step through creating applications for AutoCAD using Autodesk's ObjectARX programming libraries.

Ransen's ObjectARX Course was devised by Owen Ransen, a registered AutoCAD applications developer who is also the author of "Programming AutoCAD in C/C++" (Wiley and Sons 1997). Having faced the same problems that other real-world developers face, he saw a need for a general and useful way of introducing AutoCAD C++ programming since the official Autodesk documentation is very detailed but sometimes too much so. Ransen's ObjectARX Course offers tutorials, practical examples, and help files

written in a programmer-friendly language.

Each chapter consists of a concept overview followed by a detailed explanation, with a self-test summary quiz to check that the student has absorbed the concept. A laboratory exercise for practical experience of the ideas introduced concludes each chapter.

Subjects covered in Ransen's ObjectARX Course include "Getting Started," "An ARX View of AutoCAD Drawings," "How to Create 2D and 3D Objects," "Handling Layers and Blocks," and many others. A valuable feature that programmers will appreciate is the Help File, which covers in a practical way many important problems that AutoCAD programmers face.

To make use of this course a knowledge of C++ to a medium level is required, and experience in using AutoCAD is also an advantage. The ObjectARX 2000 SDK file, available as a free download from the Autodesk website, is also needed.

Ransen's ObjectARX Course costs \$59.00 and can be ordered in the USA from: **Saelig Company LLC**, 1193 Moseley Road, Victor, NY 14564 USA, Fax: **716-425-3835**, Tel: **716-425-3753**, E-Mail: [saelig@aol.com](mailto:saelig@aol.com). For international orders and a demo version see the WEB site <http://www.ransen.com>



# SATISFACTION GUARANTEED

Netcom Friendly Staff Since 1983

## Cruiser & Work Horse

### Compaq LTE ELITE 486 DX4-75

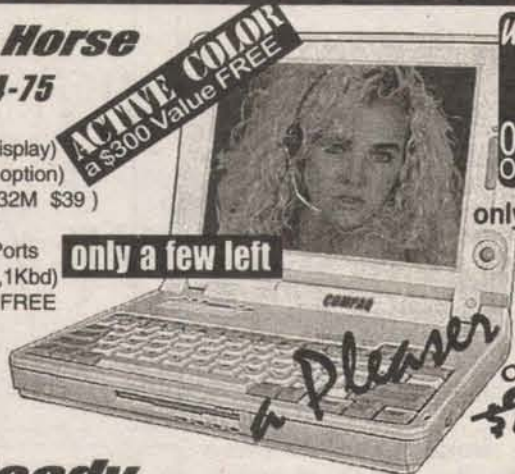
9.5" Active Matrix Display  
(Sharper & Brighter than a standard display)  
810m Standard Hard Drive -or- (1gig \$29 option)  
16M Ram Standard -or- (24M \$19 option / 32M \$39)  
28.8k FAX MODEM -or- (33k \$15 option)  
2-PCMCIA Expansion Slots & All Standard Ports  
(1S,1P,1VGA,1Kbd)  
Hydride Battery (2X the Power) \$150 Value FREE  
EJECTABLE: Battery, Hard Drive & Ram  
Expandable & Upgradable  
Lifetime Compaq Tech Support  
Built-in Power Supply  
Owners Manual Software / W95

**ACTIVE COLOR**  
a \$300 Value FREE

only a few left

WOW 2 easy payments of  
**\$288!**  
0% Financing!  
On Credit Cards only

only a few left

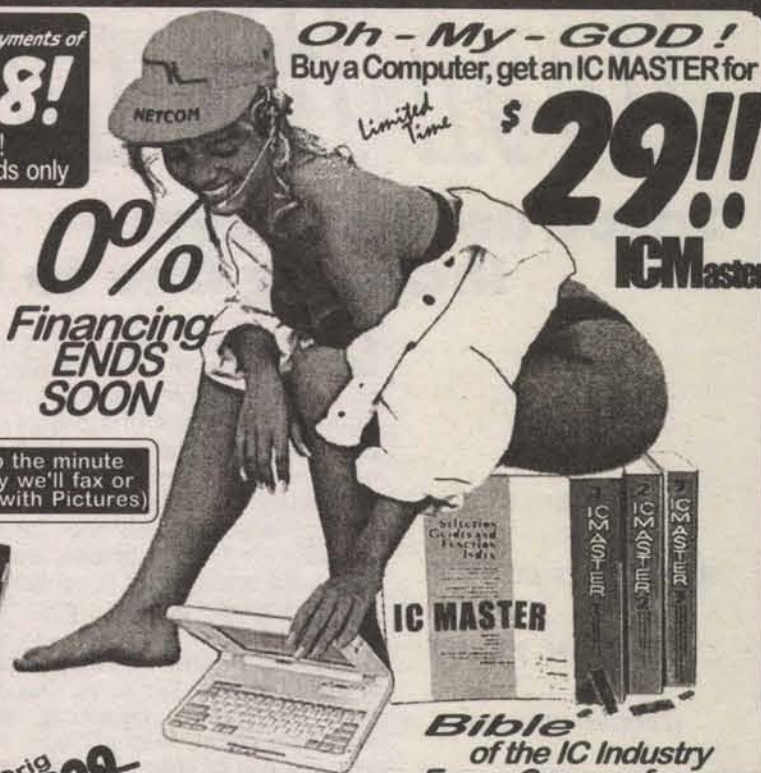


**0%**  
Financing  
ENDS  
SOON

For up to the minute  
Availability we'll fax or  
email you (with Pictures)

Oh - My - GOD!  
Buy a Computer, get an IC MASTER for

**\$29!!**  
ICMaster



**Bible**  
of the IC Industry  
Every Cross-reference  
3 Volume Set with Tons of Information

ICMaster  
\$195 Publisher

	with computer	alone	regular
\$29 95 edition	\$49	\$69	
\$39 96 edition	\$59	\$89	
\$49 97 edition	\$69	\$129	

Mega Sale Ends Soon

## Racy & Web Ready

**IBM THINKPAD 486 DX4-100**  
Huge 10.5" Active Matrix Display  
(Sharper & Brighter than a standard display)  
1 Gigabyte Hard Drive Standard -or- (2 Gig Drive \$59! Option)  
24M Ram 33k FAX MODEM  
2-PCMCIA Expansion Slots  
Dual Infrared Ports (Front & Rear)  
Track Point Mouse  
All Standard Ports (1S,1P,1VGA,1Kbd)  
Pop out - Hard Drive, Ram, & Battery  
Ram & Hard Drive Expandable & Upgradable.  
Includes Power Supply & Hydride Battery (a \$150 value)  
Internet Ready W95  
Ask about Desktop Docking Station & Port Expander

**ACTIVE COLOR**  
a \$300 Value FREE



WOW 2 easy payments of  
**\$325!**  
0% Financing!  
On Credit Cards only

Orig \$2899

**MAXIMUM  
ABUSE**

strictly for professionals

**Blazing Sunlight or Rain Storm**

On the **DESERT** or in the **SNOW**

**Instant ON - ZERO boot up time**

**Drop 3' to Concrete**

Actual Selling  
Price From IBM  
**\$6,912**

Rain: (4"/hr Rain w/ 40 MPH Winds)  
Silicone Rubberized & Diecast Case!  
Ultra Shock Mounted 1GIG EIDE Hard Drive!  
ESD / EMF & RF Resistant, Works from -4 to 120 Deg F  
& Vacuum to 15,000 ft

- > 1- PCMCIA (type 1, 2 or 3), Serial & Parallel Ports in rear
- > 3.5 Floppy, 16m Ram / 1m Video / Local Bus 486-50 mhz & Math Co-processor, 28.8k Modem (Internet Ready)
- > Long Lasting Hydride Battery (\$150 Value)
- > Sound & Microphone
- > 8.25" Display-64 Shade Monochrome REFLECTIVE
- > (Optional) Touch Screen with

Handwriting Recognition

Rough Service Handle with Loops for optional Shoulder Strap  
Roxanne's Voice Annotates all Windows 3.X Functions  
(a real kick)

Compatible with W95 / Optional 12V Car cord \$29

**This was a unique (one shot) purchasing opportunity**  
**IT'S NOT OPEN STOCK**

**WHEN THEY'RE GONE, THEY'RE GONE FOR GOOD**

Sold till recently by IBM through their Local Area Network Division  
at \$4,699 & \$6,912 as equipped here. (they were never discounted)

**IBM ROAD WARRIOR**  
An Extremely Serious Piece of Equipment

WOW 2 easy payments  
**\$399!**  
0% Financing!  
On Credit Cards only



For up to the minute  
Availability we'll fax or  
email you (with Pictures)

**Notebook  
Attache'**

**\$39**  
with purchase  
**\$59**  
alone  
**\$139**  
in Office Max



Style may vary slightly



1 Year Warranty - Satisfaction Guaranteed - The Friendliest People - The Best Customer Service  
2 PAYMENT PLAN with Credit Card -or- Layaway ONLY 843-650-5700 For Questions -or- email: netcomd@aol.com  
COD's SINGLE PAYMENT ONLY ORDERS ONLY 800-733-3733 ORDERS ONLY FAX 843 650 5777 10am-8pm Mon-Sat



# Open Channel

by Joseph J. Carr

## Spectrum Analyzers — Including One to Build

Spectrum analysis becomes possible when the various frequency components and noise are measured and displayed. Over the years, several approaches have been taken to spectrum analysis: Fourier analyzer, tunable filters, and spectrum analyzers.

Signals can be represented in a number of ways. The most familiar is the time domain representation shown in Figure 1A. This view of a pair of signals plots their amplitudes against time, so reveals their wave shapes (in this case, sinusoidal). From an amplitude-vs.-time display, one can tell the frequency (because  $F = 1/T$ ), amplitude, and wave-shape. An oscilloscope is normally used to view the time domain aspect of a signal.

Another view is the frequency domain shown in Figure 1B. This display plots amplitude-vs.-frequency, so the same two signals seen in Figure 1A will plot as a pair of spikes in Figure 1B. The comprehensive view of signals requires that we take a look at both time domain and frequency domains. Because they share a common axis — amplitude — we can view them orthogonally as in Figure 1C.

All continuous waveforms can be represented mathematically by a series of sine and cosine functions. Only the sinewave is pure in the sense that it contains only one frequency. All other waveforms, including sinewaves with even the smallest possible amount of distortion, possess a number of harmonically related frequency components. The specific harmonics, their amplitudes, and phases, determine the final shape of the overall complex wave. The complex wave can be described by a mathematical device called a Fourier series.

### Using the Frequency Domain

If we were certain that all signals in a system were pure sinewaves, there was no modulation or heterodyne mixing taking place, and that all stages in the system are perfectly linear, then the time domain display seen on an ordinary oscilloscope would suffice for practical purposes. But that never happens. Real signals have distortion, undergo both modulation and frequency mixing, and

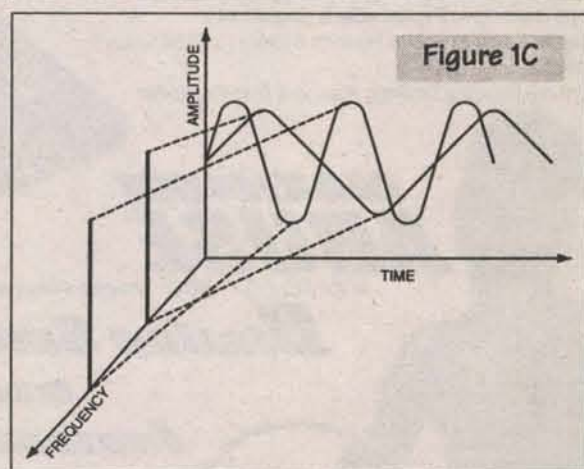
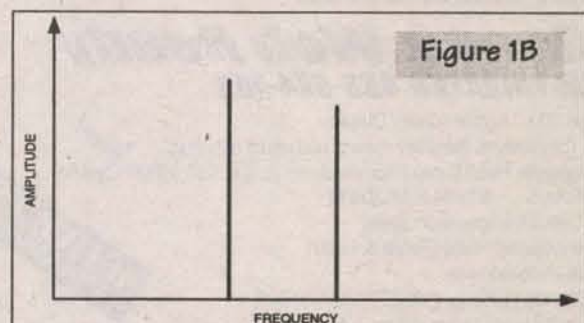
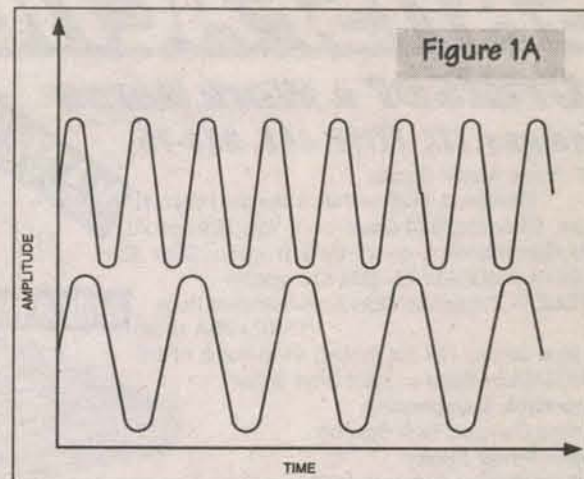
never see a perfectly linear signal processing stage.

The principal uses of a spectrum analyzer are to examine noise, distortion, mixing action, and modulation. It is necessary to characterize signals going into and coming out of a system in order to understand how the system acts on the signal. By examining the "goes into and goes out-of" we can characterize the system and determine its performance.

**Noise.** Figure 2A shows a frequency domain characterization of a noise signal. Understanding the noise spectrum allows us to either evaluate or design the system to best overcome its effects. The noise spectrum therefore permits us to spot problems in system performance, and design accordingly.

**Harmonic Distortion.** When a pure sinewave is passed through a non-linear stage, harmonic components are generated. These new frequencies are integer multiples of the fundamental frequency ( $2F, 3F, 4F \dots nF$ ). When a non-pure sinewave (which has its own harmonics) is processed in a non-linear stage, additional harmonics or increased harmonic amplitudes are created. Figure 2B shows the frequency spectrum of a waveform with multiple harmonics present. The tallest spike represents the fundamental frequency sinewave, while the smaller spikes are the harmonics.

**Intermodulation Distortion.** While harmonic distortion occurs on a single signal, intermodulation distortion (IMD) occurs when two or more signals mix in a non-linear circuit. When this occurs, additional frequencies are generated according to the rule  $mF1 \pm nF2$ , where  $m$  and  $n$  are either zero or integers. Figure 2C shows this action when two equal amplitude signals ( $F1$  and  $F2$ ) interact in a non-linear manner. The two small peaks are particularly interesting in amplifier and receiver designs because they fall close to  $F1$  and  $F2$  (other products fall very far away). These are the



2F1-F2 and 2F2-F1 products.

When undesired, this effect is called IMD, but when the desire is to translate frequencies in a mixer circuit, the effect is called heterodyning (one circuit's trash is another's treasure).

**Modulation.** A single frequency unmodulated signal will have a spectrum consisting of a single spike in the absence of distortion. But when information is imparted to the signal, additional products are created. These show up as a spectrum similar to Figure 2D. Here we see the result when a sinewave RF carrier is amplitude modulated by a sinewave audio tone. In this case,

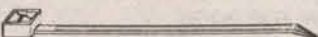
### EDSYN 951SX PROFESSIONAL SOLDERING STATION

True Temperature Control  
Static Safe  
Meets MIL-SPEC DOD2001B  
UL Listed  
70 Watt Heating Element  
Made in America

List Price  
\$249.97  
Your Price  
\$76.00



### NYLON CABLE TIES



UL Recognized  
MIL-SPEC Rated  
Made in America

Size	Per 1000
4" Natural	\$4.50
4" Black UV	\$5.00
5.5" Natural	\$8.00
5.5" Black UV	\$8.50
8" Natural	\$11.00
8" Black UV	\$12.00



Sales tax and shipping charges will be added to all orders. Prices subject to change without notice.  
1A Sales-560 N. Moorpark Road, Suite 311-Thousand Oaks-CA-91361  
888-651-9502, Fax 888-651-9503, [www.1asales.com](http://www.1asales.com), [1asales@earthlink.net](mailto:1asales@earthlink.net)

### Motron Electronics

PO Box 2748  
Eugene OR 97402-0280  
(541) 687-2118

<http://www.motron.com/>

The Auto-Kall® AK-32 Radio Telemetry/Control Boards are designed for remote control applications where direct wiring is impractical. By implementing a radio interface, the AK-32 offers both a wireless and economical solution. The AK-32 boards work in pairs and can be used for bi-directional control and contact monitoring applications. The AK-32 will work with any FM Communications or Amateur Radio transceiver (Appropriate licenses required.) The AK-32 features 16 inputs and 16 open-collector outputs designed to control 12V relays. Outputs can be connected to any of the MoTron line of Relay Boards. Programming the boards is accomplished with any DTMF source, and will retain the data in the EEPROM until reprogrammed. For additional information, visit our website, or call us at (541) 687-2118.

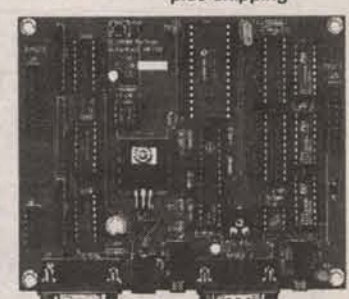


Visa, MasterCard, American Express, Discover and Government Purchase Orders accepted.  
S/H: \$8 USA; \$11 Canada; \$16 Foreign.  
Se Habla Español. Pida Por Don Moser.

Info: (541) 687-2118

Orders: (800) 338-9058 Fax: (541) 687-2492

**\$249.00**  
plus shipping



Auto-Kall® AK-32  
Radio Telemetry/Control Board





Figure 2A

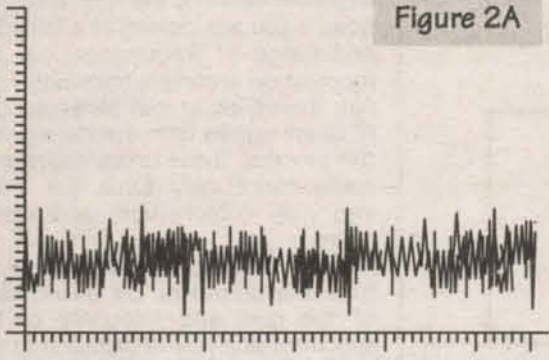


Figure 2B

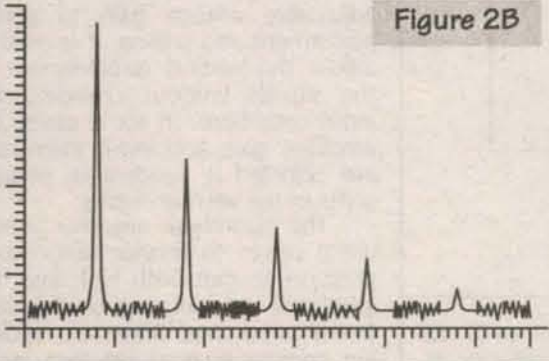


Figure 2C

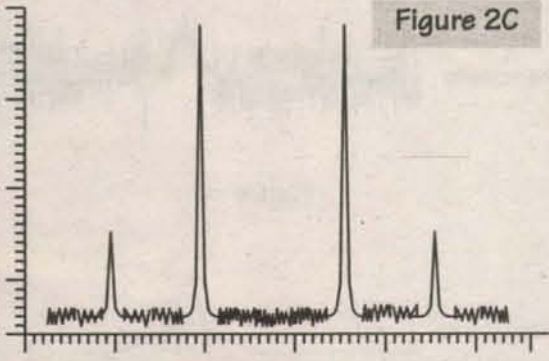
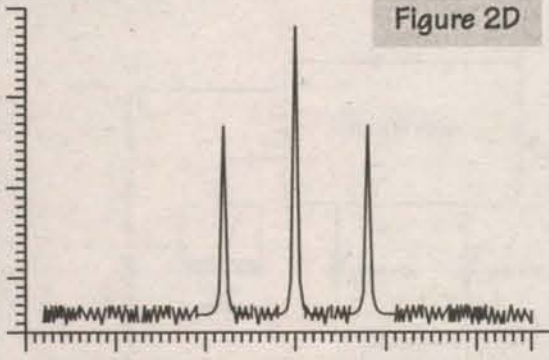


Figure 2D



a mixing action takes place, as shown clearly on the spectrum trace. If an RF carrier  $F_c$  is modulated by an audio tone  $F_a$ , then the two products are  $F_c + F_a$  and  $F_c - F_a$ . These are called the upper and lower sidebands (USB and LSB), respectively.

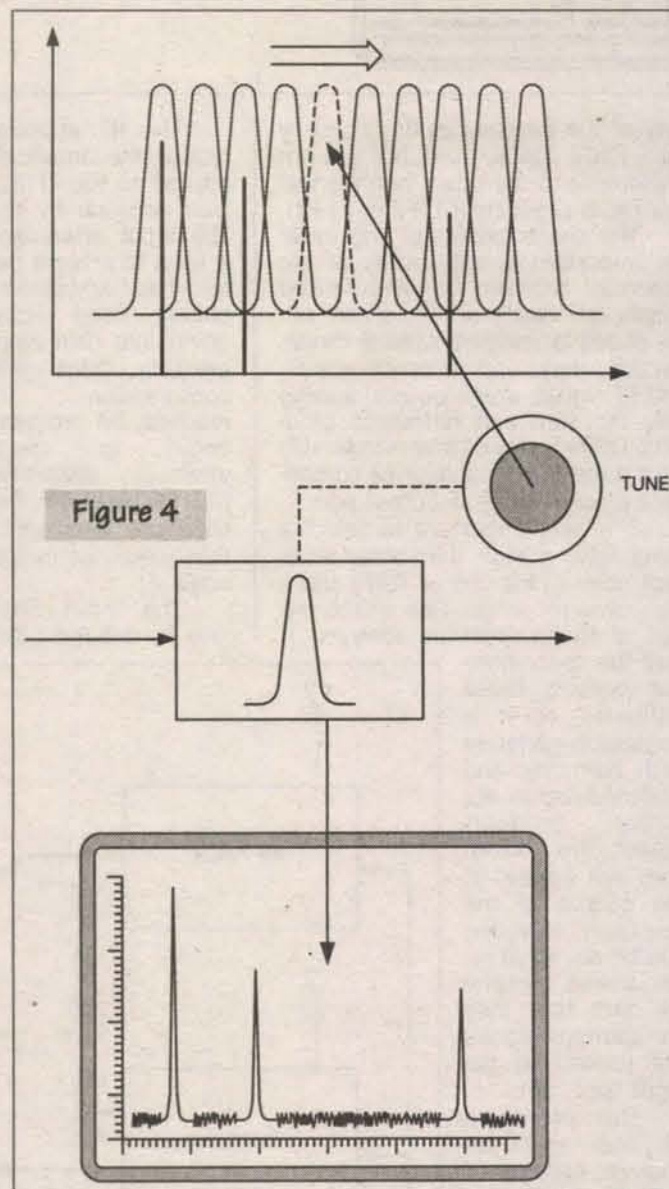
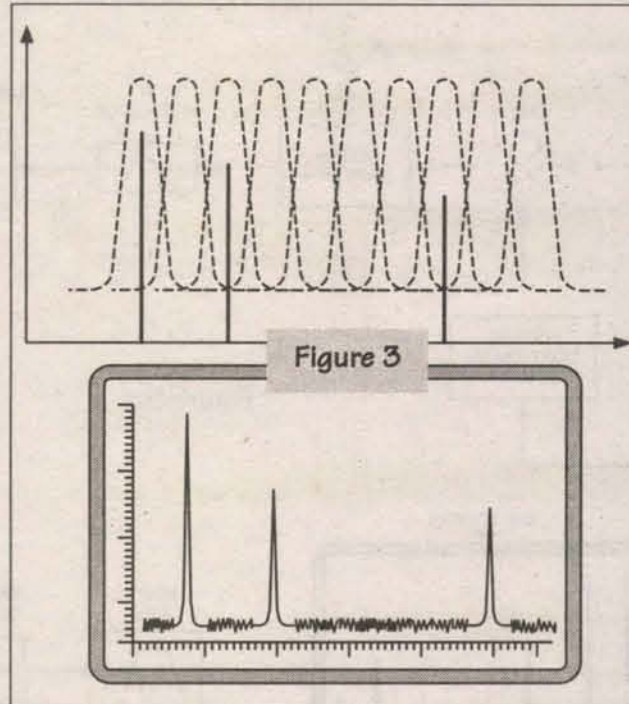
### Spectrum Analysis

Spectrum analysis becomes possible when the various frequency components and noise are measured and displayed. Over the years, several approaches have been taken to spectrum analysis: Fourier analyzer,

tunable filters, and spectrum analyzers.

The Fourier analyzer is depicted in Figure 3A, while its display is shown in Figure 3B. The analyzer consists of a series of adjacent band-pass filters, each of which passes a small amount of spectrum. When the outputs of these filters are poled, it's possible to build the display shown.

There are a number of problems with the Fourier analyzer. First, it's not terribly flexible because the filters are fixed tuned. Second, the resolution depends on the filter bandwidth,



which may not be consistent throughout the range of frequencies being measured. Finally, there is a restricted number of adjacent frequency filters that can be accommodated, especially where cost is a consideration. Finally, there may be interaction between the filters, causing a loss of performance.

The tunable filter approach is shown in Figure 4. A filter is designed to be tuned across the entire range of frequencies by manual means. In

## JFETS

ULTRA LOW NOISE  
LS843 - 3nV/Hz typ

TIGHT MATCHING  
LS843 - 1 mV max

- ◆ N & P Channel
- ◆ Duals & Singles
- ◆ Custom Screening
- ◆ Die, SMT, Thru-Hole
- ◆ No Order Minimum
- ◆ COD's Accepted

Second Source for Domestic  
& Foreign JFETs & Bipolars

Full Service U.S. Manufacturer  
of Specialty Linear Products

## LINEAR SYSTEMS

4042 Copper Court  
Fremont, CA 94538  
510-490-9160/510-353-0261(Fax)  
E-mail: 3623671@MCIMAIL.COM

Write in 97 on Reader Service Card.

## ON-LINE AUCTION

[www.gosam.com](http://www.gosam.com)

HP  
WAVETEK  
FLUKE  
TEKTRONIX  
Other electronic "stuff"  
Auctions every  
2nd & 4th week

Can't wait till your next  
swap meet? log-on@  
[www.gosam.com](http://www.gosam.com)

## PRINTERS

[samelectronics.com](http://samelectronics.com)

Canon, HP, Epson,  
Lexmark  
Order on-line & SAVE

MONITORS  
ACER, NEC, etc.

[samelectronics.com](http://samelectronics.com)



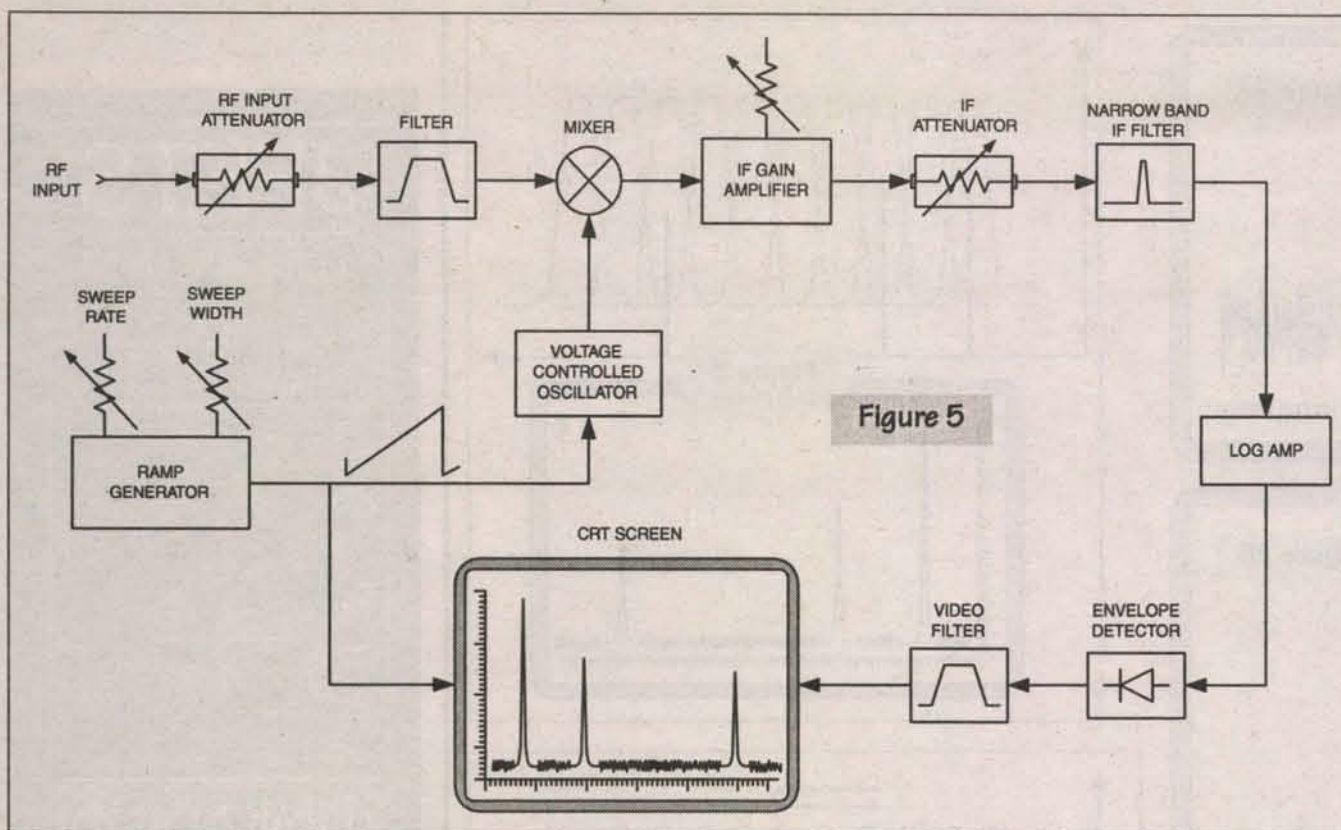


Figure 5

most cases, these instruments were actually special purpose radio receivers. When the output was calibrated, the instrument was called either a wave analyzer or tunable RF voltmeter.

Both of these approaches suffer from major faults, not the least of which is poor ease of operation. The modern spectrum analyzer solves these problems rather nicely.

## The Spectrum Analyzer

The spectrum analyzer basically automates and improves the tunable RF voltmeter. Figure 5 shows the basic block diagram for a generic spectrum analyzer. It is a narrow band receiver that is swept tuned across the range of interest. A saw-tooth ramp waveform is used to sweep tune the receiver, and to drive the horizontal deflection system of the oscilloscope. The output of the receiver is proportional to signal strength, and is applied to the vertical input of the 'scope. The result is the spectrum plot shown.

To understand the operation of the spectrum analyzer, let's take a look at each stage in its turn. The heart of the spectrum analyzer is the mixer and local oscillator (LO).

The LO is a voltage controlled oscillator (VCO) that produces an output frequency that is proportional to an applied input control voltage. In the case of the spectrum analyzer, the input voltage is a ramp, so the voltage will change as the ramp voltage rises. Because most VCO circuits have a quadratic relationship between the control voltage and frequency, it may be necessary in some cases to alter the tuning voltage waveform from a linear ramp to a shape that makes the sweep of the VCO output frequency look linear.

The mixer is a non-linear circuit that mixes the RF input signal (F1) with the LO signal (F2) to produce an intermediate frequency (IF) output.

Any of the frequencies described by  $mF1 \pm nF2$  can be used, but it is not reasonable to use other than the second-order products ( $F1+F2$  or  $F1-F2$ ).

The characteristics of the mixer are important to the quality of the spectrum analyzer. Double-balanced mixers are usually preferred over single-ended or single-balanced mixers because they tend to cancel the F1 and F2 signals in the output, leaving only the sum and difference products. Other forms of mixers invariably have a residual F1 and/or F2 component present in the IF output port.

It is very important to select a mixer with a high third-order intercept point (a.k.a. IP3 or TOIP) and a high dynamic range. One of the failings of cheap spectrum analyzers is that the mixer does not possess these attributes, so it is possible to generate both harmonic and intermodulation distortion products inside the mixer. They will appear at the output of the spectrum analyzer, and be displayed on the screen, despite the fact that they are spurious signals not present in the input spectrum.

The front-end of the spectrum analyzer consists of the mixer/LO plus any pre-processing done. There are two forms of pre-processing shown here: RF input attenuator and RF filter. Some spectrum analyzers might also have a preamplifier. It is not unreasonable to expect these stages to be switch selectable.

The RF attenuator is used to reduce the amplitude of all signals applied to the RF input of the spectrum analyzer by an equal amount.

The input attenuator is used to prevent the mixer and any preamplifiers used from going into gain compression. Once gain compression is reached, IM products begin to creep upwards distorting the picture of the spectrum with spurs that were not in the original.

The input filter may be a band pass,

low pass, or high pass filter, and is used to prevent unwanted frequencies from entering the spectrum analyzer. If you are looking at a fairly limited range of frequencies, say the modulation around a transmitter signal, then filtering can eliminate out-of-range signals from interfering with the process. Those unwanted signals could conceivably force the mixer into gain compression, and create spurs.

The IF section handles the signal from the output of the mixer. Most of the gain and selectivity of the spectrum analyzer is provided in the IF section. The principal stages are: IF gain amplifier, IF attenuator, narrow band filter, and logarithmic amplifier.

The gain amplifier provides adjustable voltage gain to permit adjustment and scaling. It is used to adjust the vertical displacement of the signals without changing the input conditions. In some cases, the amplifier gain and input attenuator are adjusted in tandem to prevent shifts in the vertical display.

The logarithmic amplifier (where used) serves to provide range compression so that both high and low amplitude products can be displayed at the same time. Otherwise, providing enough gain to see low amplitude signals will cause high amplitude signals to go off the top of the

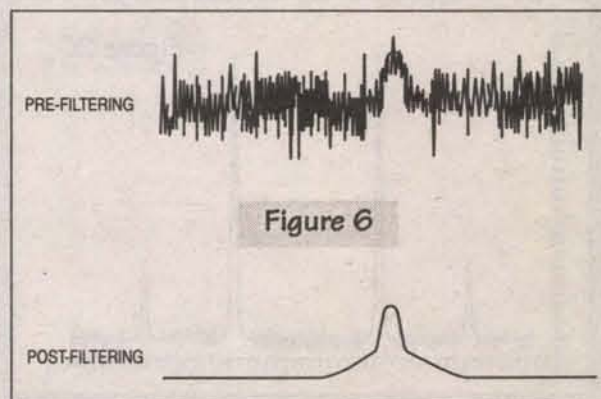


Figure 6

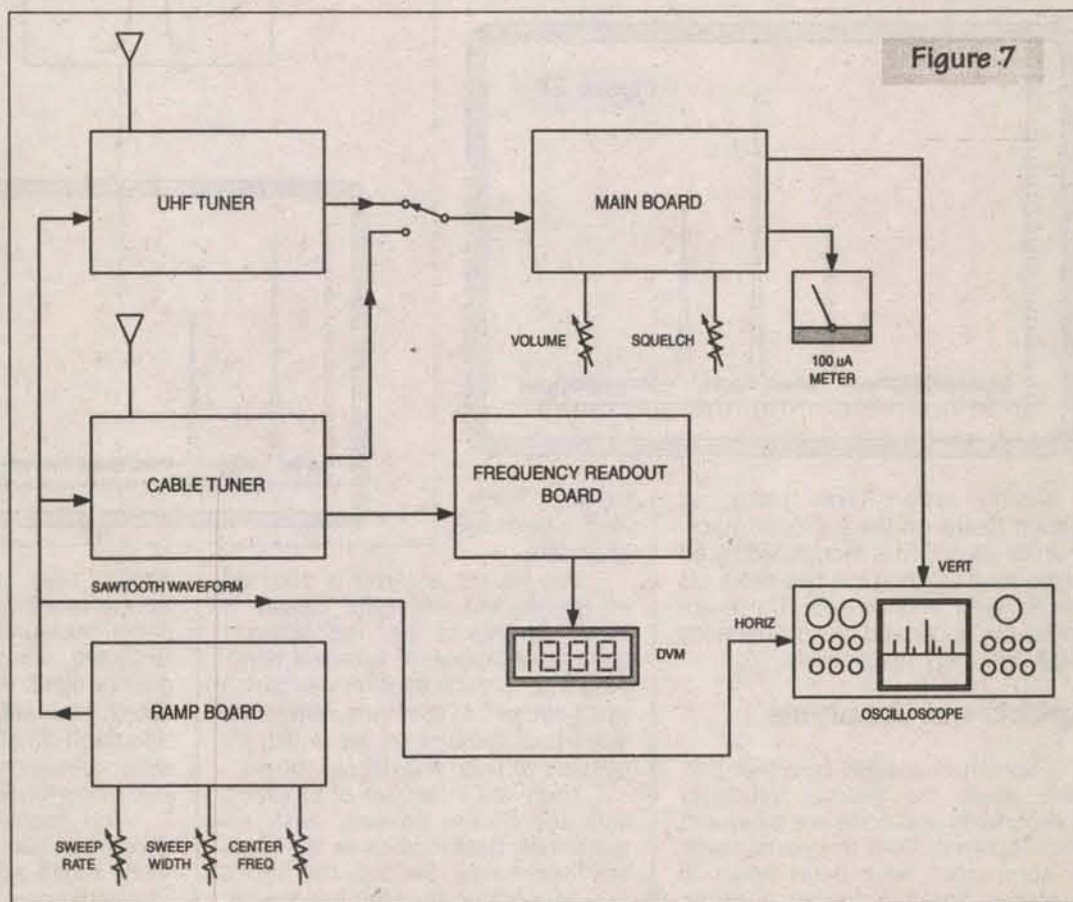


Figure 7



scale. Also, using a logarithmic amplifier permits the use of decibel notation on the CRT screen.

The video detector is an envelope detector that produces a DC output that is proportional to the signal strength at the frequency being measured. It produces the vertical deflection signal seen on the CRT screen. But this signal is often not too clean, and must be filtered. Figure 6 shows pre-filtering and post-filtering versions of a noisy waveform. The pre-filtering version is barely usable, if that.

## Poor Man's Spectrum Analyzer

Ever wondered what to do with an old, worn out, low-frequency oscilloscope? I've seen a large number of 500-KHz to 5-MHz oscilloscopes on sale at hamfests and other places for a prayer and a dime (or some such low price). But what are they used for? Any self-respecting oscilloscope will have a 20 MHz or higher bandwidth, which is why the older models are basically in the decimal dust category. Hmmmm... what to do with one of these "boatanchors"?

There is a solution. A number of years ago, I wrote a column in a magazine called *Ham Radio*. One of the projects I built for the column is a spectrum analyzer kit offered by Murray Barlowe of **Science Workshop**, P.O. Box 310N,

Bethpage, NY 11714-0310; (516) 731-7628; FAX (516) 796-1693; E-Mail: [mbarlowe@hoflink.com](mailto:mbarlowe@hoflink.com); Web site <http://www.science-workshop.com/>. I recently ran across the Science Workshop web site, and found to my delight that the project is still being offered, but with some upgrades. I obtained the pieces from Science Workshop and did it again.

The Poor Man's Spectrum Analyzer (PMSA) got its start back in 1978 when Murray demonstrated it at the Dayton Hamfest. The PMSA (Figure 7) uses cable television tuners as the front end. Two frequency ranges are available: 0-500 MHz, and UHF above 500 MHz. These tuners are voltage controlled so that the television designer can build phase locked loop (PLL) tuning. The fact that they are voltage tuned means that they can be swept through their frequency ranges. When a sawtooth waveform is applied to the tuning voltage input on the tuners, the sweeping takes place.

The cable TV tuners output the converted signal on an IF frequency close to 53 MHz (normal to TV receivers). The SW-6006 main board is a receiver that will downconvert the 53-MHz IF signal to a low IF of 10.7 MHz, and then demodulate it. The bandwidth of the output signal is approximately 250 KHz, so there is a resolution problem that may be a problem on crowded bands. The problem does not prevent you from using the device to check the output

of a transmitter for spurs and harmonics, however. Fortunately, there is a Switched Filter Upgrade kit (SW-6010) that permits selection of 250 KHz, 55 KHz, or 15 KHz bandwidths.

It should also be possible to use a regular VHF receiver as the IF, and get even better resolution. A number of general coverage receivers will go to the required range. Alternatively, there are ham radio six-meter band converters that can be used as well. However, my experience with the Science Workshop product indicated that the SW-6006 worked satisfactorily for my purposes.

The sawtooth waveform needed to sweep the tuner through the range (with Center Frequency, Sweep Width, and Sweep Rate controls) is provided by the Ramp Board (SW-6001).

One of the problems with the original PMSA that I built was the necessity of calibrating the frequency dial. I used a chart comparing 0-999 micrometer dial (connected to the tuning voltage potentiometer) readings to frequency. The current offering has a Frequency Readout Board (SW-6007) that converts the pre-scaler output of the cable-TV tuner to drive a digital voltmeter that serves as the frequency readout.

Frequency can also be measured using an optional Marker Generator (MSG-100). This is also a cable TV tuner in which the voltage tuned local oscillator is used to provide a signal to mix with the front-end signal. It puts a "pipper" on the oscillo-

scope display that indicates frequency. By measuring this frequency with a digital frequency counter, we can make accurate determinations of frequency.

Also available is a Tracking Generator upgrade (SW-5900). This type of instrument is basically a signal generator that tracks the spectrum analyzer center frequency. It can therefore be used to make frequency response measurements of circuits and devices. The tracking generator was a really neat addition to the system because it permits testing that is not possible with the PMSA alone.

The various pieces of the PMSA are available from Science Workshop in either kit form or wired and tested. Add a "K" to the kit number for kit, and "W" for wired.

The bottom line is that the Poor Man's Spectrum Analyzer is one way to get a reasonably performing spectrum analyzer without laying out a huge amount of cash. Will it do everything that a \$30,000.00 professional model will? Nope, but that's not the question. The real question is: Will it do the jobs that you need it to do? **NV**

## Connections ...

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at [CARRJJ@AOL.COM](mailto:CARRJJ@AOL.COM).

**Davilyn CORP.**

13406 Saticoy Street  
North Hollywood, CA 91605  
800-235-6222  
818-787-3334 • F-818-787-4732  
[HTTP://WWW.DAVILYN.COM/ELECTRONICS](http://www.Davilyn.com/Electronics)

### SEXTANT

Aircraft or marine navigation. No case. **\$50**

### SINGER CSM-1 COMMUNICATIONS SERVICE MONITOR

RF signal source: 0 to 800MHz in 100MHz steps plus 100Hz vernier. RF output: 110 to 0 dBm, built-in oscilloscope monitor. Inputs: RF, detected, vertical, horizontal, AM/FM. Outputs: audio, tone, RF. Functions: generate 2mV to 2mV. AGC: manual or auto. **\$295**

### BOX \$15



### FIBERGLASS, WATERPROOF

Exterior size (L) 14-1/2" x (H) 9-3/4" x (W) 14-3/4"

- HP 200CD Oscillator ..... \$95
- HP 312B Selective Voltmeter .. \$695
- HP 331 Distortion Analyzer ... \$249
- HP 400E Voltmeter ..... \$325
- HP 412A Voltmeter ..... \$95
- HP 415E Voltmeter ..... \$125
- HP 3435A Multimeter ..... \$295
- HP 8160A Generator ..... \$2,800
- Krohn-Hite Model 4300A Oscillator ..... \$395
- PRD Type 2020 Vector Voltmeter w/sampling heads ..... \$250
- Syston Donner Spectrum Analyzer Consists of tuning unit Model 809-1, display unit Model 712-1 ..... \$1,995
- Watkins Johnson WJ-8628-4 Receiver ..... \$8,500

### MORGAN DATA SYSTEMS MODEL 8609

Constant voltage or current power supply voltage range: 0 to 50 volts. Current range: 0 to 1.5A. Readout: 3 digit with 0.1 volt and 1mA current resolution. Regulation: linear; input voltage: 115V/220V. Adjustments: voltage and current has remote control adjustment capability. **NEW. Price: \$95**

### TELEGRAPH KEYS

Unique item for military collectors. J37 telegraph key, new in original government package. **\$49.95**



**GREAT PRICE**  
**HP 180A SCOPE (MIL SPEC AN/USM-281A)**  
Includes vertical plug-in 1801A (PL1186), horizontal plug-in 1821A (PL1187). Tested. Manual Reproduction: 15 **\$195**



**TS-723A SPECTRUM ANALYZER**  
Frequency range 20Hz to 20KHz. Noise measurement — full scale 300 microvolts, minimum -75dBm, frequency -10Hz to 20KHz. Power supply — 115V/230V, 50 to 100Hz, 90 watts. **\$95**

### JONES MODEL 1600-1 TACHOMETER

Instrument tachometer centrifugal mechanical tach measures RPM scale 0-500 RPM, coupling shaft 1/8" accessories, various size rubber tipped drive couplings, case new. Also Jones Model 1600-7 RPM scale 0-11,000 RPM w/accessories. **New \$35/ea. or 2 for \$50**

### HP 8640B SIGNAL GENERATOR OPT 003

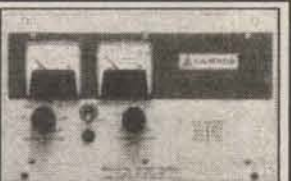
**CONDITION CODE "A"**  
Frequency: 500KHz to 512MHz. Indicates to 1024MHz. Requires external frequency doubler for 1024MHz (supplied with unit). Readout can be used as a frequency counter. Accuracy: 6.5 digits expandable to X10 and X100. Output: -145dBm to +19dBm (0.5 to 512MHz). Modulation: AM, FM, pulse, 400 and 1KHz, 1mV to 1V internal. Has input and output of modulation sources. **GREAT PRICE \$1,095**

### NICKEL CADMIUM BATTERY

G.E. Catalog No. 42B004KA01. Nominal volts 12 rated capacity 4.0Ah, wt. 5 lbs. **NEW \$55**

### LAMBDA LK344A-FM POWER SUPPLY

Front panel voltage and current meters. Convection-cooled, no blower. Voltage adjustable from 0 to 60 VDC at a maximum current of 4A. Regulation 0.015% or 1mV. Line or load. Series/parallel operation. Remotely programmable by voltage or resistance. Less than 500µV RMS ripple. Constant current/constant current. **NEW Price: \$395 NEW LOWER PRICE: \$295**



**AN/URM-120 50 OHM THRU-LINE RF WATTMETER**  
Frequency range: 2MHz to 1000MHz. Power range: 10 watts to 1000 watts. USWR≤1.08 to 1. Uses three plug-in coupler elements (included). CU-753 2 to 30MHz 50 to 100 watts CU-754 25 to 250MHz 10 to 500 watts CU-755 200 to 1000MHz 10 to 500 watts. Connector: Type N. Case included. Size: 7"Wx6-5/8"Hx7-1/5"D. Weight: 6.5 lbs. **Price: \$395**

### TEKTRONIX 2336YA DUAL TRACE 100MHz PORTABLE OSCILLOSCOPE

Vertical: DC to 100MHz band with 5 mV per div. to 5V per div. maximum sensitivity of 2mV/div. Horizontal: Time Base A: 0.05 uS/div. 0.5 sec/div. X10 to 5 ns/div. Time Base B: 0.05 uS/div. to 50 mS/div. X10 to 5 ns/div. Has digital readout of delta time, delayed sweep, and XY input div. **\$795**



**CT SYSTEMS 3000B SERVICE MONITOR**  
**\$2,580 \$1,995**



# COMPUTER CIRCULATION CENTER, Inc.

dba: Alltech Electronics

2618 Temple Heights Drive.

Oceanside, CA 92056

Phone Order Hours 9AM - 5:30PM Mon-Fri

Phone Orders

760/724-2404

\$25 -Min. Order -

9350 Clairemont Mesa, San Diego - 619/573-0411

1401 El Camino Real. Oceanside - 760/721-0093

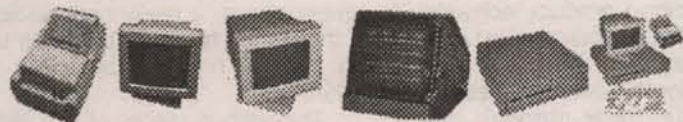
1300 E. Edinger. Santa Ana - 714/543-5011

2018 W. Lomita BLVD. Lomita - 310/539-2260

We buy surplus & excess computer inventory as well as scrap electronics related inventory.

Save on your Point of Sale systems with these refurbished and new components.  
 9" Monochrome VGA NEC \*\*NEW\*\* 640 x 480 ..... \$79.00  
 10" SVGA COLOR View Magic .26 dp Refurb (upto 1024 x 768) ..... \$139.00  
 10" SVGA Color (Open Frame - Build a custom enclosure) ..... \$119.00  
 Fujitsu Cash Drawer NEW w/till. 24VDC Trigger for drawer ..... \$79.00  
 Cash Drawer - Epson Printer - 9" Mono VGA ..... \$199.00  
 Cash Drawer - Epson Printer - 10" Color SVGA .26 dp ..... \$299.00  
 Compact footprint 83 Key keyboard - PS/2 Type ..... \$14.95  
 Epson TM300PD Parallel Receipt Printer (2 Color) Refurb ..... \$89.99

## Point of Sale Hardware



Be sure to check our Web Site for more information on these and other products!

www.allelec.com

See Our Web Site for Industrial Surplus and other related items.

www.computerchopper.com  
Get on the mailing list.

### NEC Mini 486



Need a Linux Box?  
**\$29.00**

Mini footprint  
3.5" x 11.5 x 13  
486 SX 25 CPU  
4MB On board  
2 ISA Slots  
IDE, FD, 2  
COM, 1 LPT &  
512K VGA  
Great for a  
Firewall box.

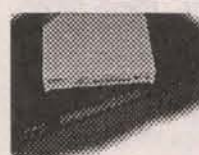
### 10" Color SVGA!

Up to 1024 x 768 pixels  
110V AC operation.

ViewMagic



Refurb:  
**\$139.00**



**\$29.00**

Refurb 8 Port Hub

Home network?  
Cable Modem?  
Linux Box?  
Various Brand  
10BaseT 8 Port  
Hubs.

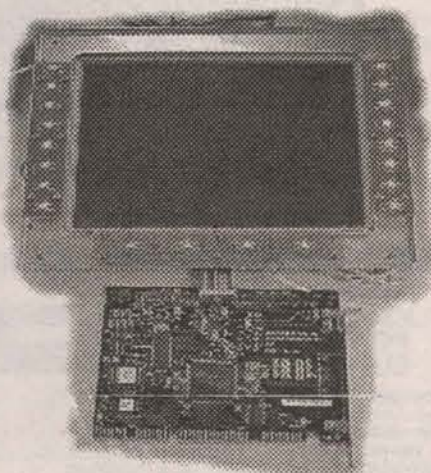


**\$9.95**

Small DC Motor w/gear box & Wheel

Robotic Attachments?  
Arms, etc?  
With rubber o-ring on 5" dia. disc.

### 9.75" Mono VGA LCD w/Controller



**\$89.00**

Great for Servers:  
Takes Power from CPU Backlight  
Great for a headless system.  
Windows NT Server Console,  
Linux Server, etc.  
16 Bit (ISA) Interface with  
Cirrus Logic GD6235  
512K RAM. Non Upgradable  
Win95/98 Compatible

See the web site for more detailed images and further information  
Assembly Dimensions:  
10" x 6.75" x 3/8"  
With Backlight Inverter board.

### Motorola Flip Phone Data Adapter



**\$39.00**

RJ-11 (Dial Tone) Generator and Ring Generator. Use any standard land line device with your cell phone. Modem, credit card terminal, answering machine...

### External SCSI 3.5" Open Face Case



Open Face for standard SCSI Zip, Jaz, SyQuest Etc..  
2.50 Pin & ID Select  
**\$19**

Large AC Motor. Use for robotic drive or ?? Has 5" disc attached with a rubber O-Ring.

**\$9.95**



Reversible 110V AC Motor with brake



**\$69.00**  
6 Sets (24)

Used 3" Dia. Wheels

360 degree rotatable. Ball Bearing for durability. These were from heavy duty mobile storage units. Each set contains 2 swivel and 2 static wheels

### 6" Mono LCD

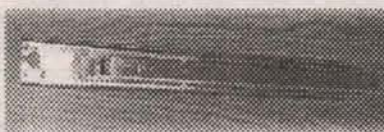


With Controller

See the web site for more details and pricing. This is a dedicated 8 Bit card with backlit LCD module and separate DC inverter for the backlight. Great for tinkering.  
www.allelec.com

### EPROMs

2716 /2732	\$1.25
2764 /27128	\$1.25
27256 /27512	\$1.50
1Meg	\$2.50
2 Meg	\$2.50



6 pair for  
**\$29.00**

Ball Bearing Drawer Slide

Extends to 2' past. Two slide telescopic extension

### TapeStor 800 & 3200



**\$39.00**

Seagate Connor Refurbished TR1 TR1 800MB TR3 3.2GB Floppy Vers. Only. S/W & Cables included. w/drive purchase T3200 3.2GB TR3...\$69.00

### PC Oldies but Goodies

EGA/CGA Card -or- ISA Super I/O	\$14.95
2 Meg AT Memory Card - or - Parallel/Mono Card	\$9.00
Floppy Controller -or- Serial / Parallel Card	\$6.95
VLB 1 Meg VGA Card - or - 386 Motherboard w/2 Meg	\$19.95
16 Bit (ISA) VGA w 256/512/1 Meg	\$9.00 / \$12.00 / \$14.95
VLB Super I/O	\$12.95
8 Bit VGA Card - or - XT Motherboard w/640K	\$9.95

See Our Website for more details on these industrial surplus items.

Robot Competition? Feeling creative? Build something!

### CD ROM & Sound Cards

4x IDE Internal	\$19.00
8x IDE Internal	\$29.00
24x IDE Internal with Yamaha Sound Card (ISA)	\$49.00
4x SCSI Internal	\$25.00
4x SCSI External	\$49.00
Universal Audio Cable (CD ROM to Soundcard)	\$4.95

HTTP://WWW.ALLELEC.COM

VISIT OUR WEB PAGE DAILY FOR SPECIALS & MORE INFO. ON THESE ITEMS

CA Residents please add 7.25% Sales tax. \* Minimum shipping & handling charges \$8.50. \* Warranty: Used/Refurbished products have a 90 day warranty. \* ALL Returns must have an RMA & call before shipping back to us. \* No Returns without an invoice. Shipping & Handling charges are non-refundable. \* 20% Restocking charge, applies to products purchased in error & incompatibility problems. School & University Purchase Orders accepted, others on AOC only. \* Prices and availability subject to change at anytime without any notification whatsoever.



# Events

# CALENDAR

JUNE 1999

JUNE 3-4-5

**IN - INDIANAPOLIS** - Antique Radio Swapmeet, Auction, Seminar. Indiana Historical Radio Society & Antique Wireless Assn., Herman Gross, 765-459-8308. E-Mail: w9itt@juno.com

JUNE 4-5

**NE - SOUTH SIOUX CITY** - Iowa State Convention. 3900 Club & Sooland ARA, Mike Nickolaus NF0N, 402-494-6070. E-Mail: nf0n@avalon.net Web: http://www.pionet.net/~k0brd/hamboree/

JUNE 4-5-6

**NY - ROCHESTER** - Atlantic Division & NY State Convention. Monroe County Fairgrounds. Fri: 12pm-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Harold Smith K2HC, 716-424-7184. Fax: 716-424-7130. E-Mail: rochfst@frontier.net Web: http://www.rochesterhamfest.org

JUNE 5

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052

**FL - MCCOY** - Hamfest. Ft. McCoy ARC, Tom Bench KS4ZI, 352-546-3967. E-Mail: ks4zi@arrl.net Web: http://www.qsl.net/w4frc

**IL - SPRINGFIELD** - Hamfest. Illinois State Fairgrounds. 8am-1pm (flea 6am). VE Exams. Talk-in: 146.685 (-). Sangamon Valley RC, Ed Gaffney KA9ETP, 217-628-3697. E-Mail: egaffney@fgi.net Web: www.skylight1.com/svrc/

**ME - HERMON** - Hamfest. Hermon High School. 8am-1pm. VE Exams. Talk-in: 146.34/94, 146.52. Pine State ARC, Roger Dole KA1TKS, 207-848-3846. E-Mail: dolerw@juno.com

**MI - GRAND RAPIDS** - Hamfest. Hudsonville Fairgrounds. VE Exams. Talk-in: 147.160 link repeater system. Independent Repeater Assn., Kathy KB8KZH, 616-698-6627 4-7pm.

**MI - ST. PAUL** - Hamfest. TwinsLan ARC, Ann Foster N0LLC, 612-706-1761. E-Mail: tailgate@twinslan.org Web: http://www.twinslan.org/tailgate.html

**MO - HOUSTON** - Hamfest. Ozark Mountain Repeater Group, Bob Simpson N0NTC, 417-967-3535. E-Mail: n0ntc@train.missouri.org

**NJ - TEANECK** - Hamfest. Bergen ARA, Jim Joyce K2ZO, 201-664-6725. E-Mail: jjoyce@cybernet.net Web: http://www.bara.org

JUNE 5-6

**GA - MARIETTA** - Hamfest. Jim Miller Park. Atlanta Radio Club, Ben Dasher KE4YZX, 404-869-6959. E-Mail: bendasher@mindspring.com Charles Golsen N4TZM, 404-252-3303 or 404-688-6278. E-Mail: cgolsen@atlanta.com Web: http://www.saf.com/arc

**NE - CHADRON** - Hamfest. Pine Ridge ARC, Lynn Bilyeu K0ODF, 308-432-2297. E-Mail: lynn@bbc.net

**OR - SEASIDE** - SEAPAC NW Division Ham Convention. Seaside Convention Center, 1st St. VE Exams. Talk-in: 146.66 (-). Oregon Tualatin Valley ARC, Al Berg W7SIC, 503-640-5456; Randy Stimson KZ7T, 503-297-1175. E-Mail: rastimson@att.net Web: http://www.otv.oregon.net/events/hamfairs/seapac/index.htm

JUNE 6

**CT - NEWINGTON** - Flea Market. Newington High School, Willard Ave. (Rt. 173). 9am-1pm. FCC Exams. Talk-in: 145.45 & 146.52 simplex & 224.84, 443.05. Newington AR League, John Disaro KA1HQK, 860-666-8569; Joe Bottiglieri AA1GW, 860-666-9692. E-Mail: aalgw@arrl.net

**IL - PRINCETON** - Hamfest. Starved Rock RC, Frank Carraro KF9NZ, 815-856-3773. E-Mail: w9mks@qsl.net Web: http://www.qsl.net/w9mks/

**IN - WABASH** - Hamfest. Wabash County 4-H Fairgrounds, SR 13N. 6am. Talk-in: 147.03/147.63 & 442.325/447.325. Wabash County ARC, Ralph Frank, 219-563-8487 (W), 219-563-8489 (F), 765-833-7372 (H). E-Mail: wial@netusa.net Web: www.netusa.net/~qrziota/

**MI - CHELSEA** - Hamfest. Chelsea ARC, Don Wilke W8WM, 734-475-2359

**NY - QUEENS** - Hamfest. Hall of Science parking lot, Flushing Meadow Park, Corona, 47-01 111th St. 9am-3pm. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599. E-Mail: WB2KDG@Bigfoot.com

**OH - MEDINA** - Hamfest. County Fairgrounds, Community Center, 735 Lafayette Rd. 8am-3pm. Talk-in: 147.630 in, 147.030 out. Medina 2 Meter Group, Mike Rubaszewski N8TZY, 330-273-1519. E-Mail: m2mg@aol.com Web: http://members.aol.com/m2mggroup

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:

**Nuts & Volts Magazine**

**Events Calendar**

430 Princeland Court

Corona, CA 91719

Phone 909-371-8497

Fax 909-371-3052

E-mail events@nutsvolts.com

## COMPUTER SHOWS

**AGI Shows**, 317-299-8827. E-Mail: info@agishows.com http://www.agishows.com

**Blue Star Productions** 612-788-1901 http://www.supercomputersale.com

**Computers And You**, 734-283-1754. www.a1-supercomputersales.com

**Computer Central Shows** 847-412-1900 & 1-888-296-6066. E-Mail: compcent@megsnet.net www.computercentralshows.com

**Five Star Productions** 810-890-0988 E-Mail: jeff@fivestar www.fivestarshow.com

**Georgia Mountain Productions** 706-838-4827. E-Mail: gamtpro@blrg.tds.net georgiamountain.com

**Gibraltar Trade Center, Inc.** 734-287-2000. Taylor, MI.

**Gibraltar Trade Center, Inc.** 810-465-6440. Mt. Clemens, MI.

**KGP Productions** 1-800-631-0062, 732-297-2526. E-Mail: kgp@mail.com

**MarketPro, Inc.**, 201-825-2229 http://www.marketpro.com

**MarketPro, Inc.**, 301-984-0880. E-Mail: md@marketpro.com http://marketpro.com

**Narisaam Computer Show** 770-663-0983. E-Mail: narisaam@aol.com Web: http://www.showsale.com

**Northern Computer Shows** 978-744-8440. E-Mail: inquiries@ncshows.com Web: ncshows.com

**Peter Trapp Computer Shows**, 603-272-5008. Web: www.petertrapp.com

(107.2). Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. E-Mail: WA9RIJ@MC.NET

Web: http://cyberconnect.com/orion/smcc.html

**KY - INDEPENDENCE** - Ham-O-Rama '99. Summit View Middle School, 5002 Madison Pike (KY 17) 8am-3pm. Talk-in: 147.255+ or 147.375+ repeaters. Northern KY ARC, Robert Blocher N8JMV, 513-797-7252. E-Mail: nkarc@juno.com

**NY - BETHPAGE** - Long Island Hamfair. Briarcliffe College, 1055 Stewart Ave. 8:30am-2pm. VE Exams. Talk-in: W2VL 146.85 repeater (136.5PL). Long Island Mobile ARC, Rich N2WJL, 516-520-9311. E-Mail: hamfest@limarc.org Web: http://www.limarc.org

**OH - AKRON** - Hamfest. Goodyear ARC, Robert J. Taylor KB8ZEC, 330-836-3282. E-Mail: rtaylor@akron.infi.net

**TN - KNOXVILLE** - Hamfest & TN State Convention. National Guard Armory, 3330 Sutherland Ave. 9am-4pm. VE Exams. Talk-in: W4BBB 147.30 (+) & 224.50 (-) & 444.575 (+). Radio Amateur Club of Knoxville, David Bower K4PZT, 423-974-5064 (W), 423-670-1503 (H). E-Mail: rack@kornet.org or d.bower@ieee.org Web: http://www.kornet.org/rack

JUNE 18-19-20

**CANADA - ALBERTA - RED DEER** - Hamfest. Central Alberta Radio League, Bob King VE6BLD, 403-782-3438. E-Mail: kingel@telusplanet.net or ve6bld@rac.ca Web: http://qsl.net/carl/

JUNE 19

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-In. 619-561-0052

**CANADA - BC - KELOWNA** - Hamfest. Orchard City ARC, 250-766-2179. E-Mail: ve7kng@rac.ca Web: http://www.okapagan.net/ocarc

**CANADA - ON - MARMORA** - Hamfest. Tri-County ARC, Paul Davidson VE3UQM, 613-472-3449. Pete Blakely VA3PGB, 613-473-1171. E-Mail: rhobson@bvl.igs.net

Web: http://www.redden.on.ca/~tcarc/tricity.htm

**MI - MIDLAND** - Hamfest. Midland County

Fairgrounds, Gerstacker Fair Center. 8am-1pm. VE Exams. Talk-in: 147.00 (+) (W8KEA repeater). Midland ARC, Del Lafavor WB8FYR, 517-636-5097 (w), 517-689-3477 (h).

E-Mail: lafevord@aol.com Web: http://www.qsl.net/w8kea/MARCSWAP.htm

**NJ - DUNELLEN** - Hamfest. Columbia Park, near Rt. 529 & Rt. 28 intersection. 7am-2pm. Talk-in: 146.025/625 & 146.52 simplex. Raritan Valley RC, Bob Pearson WB2CVL, 732-846-2056 or Fred Werner KB2HZO, 732-968-7789 before 8pm. Web: http://www.w2qw.org

**OH - MILFORD** - Hamfest. Milford ARC, Chris Reinfelder KB8SNH, 513-753-5066. E-Mail: RAC Reinfelder@FUSE.NET

**WV - BLUEFIELD** - Hamfest. Brushfork Arm. East River ARC, Don Williams WA4K, 540-326-3338. Web: http://www.inetone.net/erarc/hamfest/

JUNE 20

**CA - ORCUTT** - Santa Maria Hamfest. Satellite ARC, Eric Lemmon WB6FLY, 805-733-4416. E-Mail: wb6fly@impulse.net

**IN - CROWN POINT** - Dad's Day Hamfest. Lake County Fairgrounds. 8am. VE Exams. Talk-in: 147.00, 146.52 & 442.075. Lake County ARC, Malcolm Lunsford W9MAL, 219-769-3925 (ph) or 815-361-1913 (fax). E-Mail: w9mal@cris.com

**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XMR PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

**MD - FREDERICK** - Father's Day Hamfest. Frederick County Fairgrounds, 797 E. Patrick St. 8am-3pm. VE Exams. Talk-in: K3ERM 146.640 (-) & 147.060 (+) & 146.52 simplex. Frederick ARC, Carolyn Moroney N3VOK, 301-831-5060. E-Mail: n3vok@erols.com

**MI - MONROE** - Hamfest. Monroe County Fairgrounds. Monroe County Radio Communications Assn., Fred VanDaele KA8EBI, 734-587-7165 days or 734-242-9487 eves.

**OH - MACEDONIA** - Hamfest. Cuyahoga ARC, Rich James N8FIL, 1-800-404-2282. Web: http://www.cars.org



# Events CALENDAR

**JULY 1999**

**JULY 3**

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**KY - TOMPKINSVILLE** - Hamfest. The National Guard Armory, Hwy. 163 N. Talk-in: 146.775 repeater. Monroe County ARC, David Welch K4PL, 502-678-5784. J. Bunch, 502-678-5784. E-Mail: dwelch@glasgow-ky.com

Web: <http://monroearc.hypermart.net>

**NC - SALISBURY** - Hamfest. Firecracker

Hamfest. Civic Center. Rowan ARS, Ralph Brown WB4AQK, 704-636-5902.

E-Mail: [rbrown@salisbury.net](mailto:rbrown@salisbury.net)

Web: <http://home.interpath.net/kk4lh/hamfest>

**PA - LEHMAN** - Wilkes-Barre Hamfest. Luzerne County Fairgrounds, Rte. 118 (I-81 Exit 47B to Rt. 309 to Rt. 415 to Rt. 118). 8am. FCC Exams. Talk-in: 146.52 & 146.61. Murgas ARC, Stan Perry KE3TC, 570-735-2385; E-Mail: [slperry@epix.net](mailto:slperry@epix.net) Bob N3FA, 570-288-3532

**JULY 4**

**PA - BRESSLER** - Firecracker Hamfest. Emerick Cibort Park, Penn St. 8am. VE Exams. Talk-in: 146.16/76 & 146.52 simplex. Harrisburg RAC, Richard Bordner W3NJB, 717-939-4825.

E-Mail: [n3njb@aol.com](mailto:n3njb@aol.com)

**JULY 9-10-11**

**CANADA - MANITOBA - BRANDON** - Hamfest. International Peace Garden, Dave Snyder VE4XN, 204-728-2463. E-Mail: [dsnyder@mb.sympatico.ca](mailto:dsnyder@mb.sympatico.ca)

**JULY 10**

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

**CANADA - ONTARIO - MILTON** - Hamfest. Burlington ARC, Alan Montgomery VE3FCJ, 905-332-5282. E-Mail: [ontariohamfest@canada.com](mailto:ontariohamfest@canada.com)

Web: <http://www.bigwave.ca/~ve3coj/barc/flyer>  
**GA - GAINESVILLE** - Hamfest. Lanierland ARC, Ken Parrish KN4UO, 770-867-9833. E-Mail: [kn4uo@mindspring.com](mailto:kn4uo@mindspring.com)

Web: <http://www.qsl.net/kc4oxp/index.htm>

**IN - INDIANAPOLIS** - ARRL Central Division Convention, Rick Ogan N9LRR, 317-251-4407.

E-Mail: [ogandr@in.net](mailto:ogandr@in.net)

Web: <http://www.indyhamfest.com>

**MD - BRUNSWICK** - Hamfest. Mid-Atlantic DX & Repeater Assn., Roy Bates N2CSQ, 301-834-9351. E-Mail: [MADRA@qsl.net](mailto:MADRA@qsl.net)

**ME - UNION** - Hamfest. Fairgrounds. Pen-Bay ARC, Will Chadwick WC1W, 207-785-2739. E-Mail: [wilchad@tidewater.net](mailto:wilchad@tidewater.net)

**MI - PETOSKEY** - Swap & Shop. Emmet County Fairgrounds, US 31, 2 blks W of 131. 8am-1pm. VE Exams. Talk-in: 146.68 (-). Straits Area ARC, Tom WB1ZS, 616-539-8459; Dirk KG8JK, 616-348-5043. E-Mail: [kg8jk@qsl.net](mailto:kg8jk@qsl.net)

**MO - KANSAS CITY** - Midwest Division Convention, Bob Roske WA0CLR, 816-436-0069.

E-Mail: [wa0clr@worldnet.att.net](mailto:wa0clr@worldnet.att.net)  
Web: <http://members.tripod.com/~PHDARA/>

**NY - BATAVIA** - Hamfest. Genesee fairgrounds. 6am-3pm. Talk-in: W2RCX 147.285+. "Gram," Harold Hay, 716-343-2844.

E-Mail: [wa2abq@aol.com](mailto:wa2abq@aol.com)

**TX - TEXAS CITY** - Hamfest.

Tidelands ARC, Joe Wileman AA5OP, 409-945-6794

**WI - EAU CLAIRE** - Hamfest. Eau Claire ARC, Jim Staats KG9MV, 715-838-9108. E-Mail: [kg9mv@arrl.net](mailto:kg9mv@arrl.net)

Web: <http://www.ecarc.org>

**WI - OAK CREEK** - Swapfest. American Legion Post 434, 9327 S. Shepard Ave. 6:30am-2pm+ CDT. Talk-in: 146.52 (WA9TXE). South Milwaukee ARC, Inc., 414-762-3235

**JULY 11**

**IL - PEOTOME** - Hamfest. Will County Fairgrounds. Talk-in: 146.94.

Kankakee Area Radio Society, Billie Kerouac KF9IF, 815-939-7548. E-Mail: [dkbk@megsnet.net](mailto:dkbk@megsnet.net)

Web: <http://www.geocities.com/capecanavera/hanger/5711>

**NY - PATCHOGUE** - Hamfest. Mid-Island ARC, Mike Grant N2OX, 516-736-9126.

E-Mail: [globalcm@erols.com](mailto:globalcm@erols.com)

Web: <http://www.qsl.net/mid-islandarc/hamfest.html>

**OH - BOWLING GREEN** - Hamfest. Wood County ARC, Bob Boughton N1RB, 419-354-1811. E-Mail: [boughton@bgsu.edu](mailto:boughton@bgsu.edu)

Web: <http://bravals.bgsu.edu/~boughton/wcarc.html>

**PA - KIMBERTON** - Valley Forge Hamfest. Fire Co. Fairgrounds, Rt. 113 (S of Rt. 23). 8am. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: [hamfest-info@marc-radio.org](mailto:hamfest-info@marc-radio.org)

Web: <http://www.marc-radio.org/hamfest.html>

**PA - PITTSBURGH** - Hamfest. Northland Public Library, 300 Cumberland Rd. 8am-3pm. Talk-in: 149.09 W3EXW. North Hills ARC, H. Rey Whanger W3BIS, 412-828-3694 (ph & fax). E-Mail: [w3bis@freeweb.com](mailto:w3bis@freeweb.com)

Web: <http://nharc.pgh.pa.us/>

**JULY 16-17-18**

**MT - EAST GLACIER** - Montana State Convention, Darrell Thomas N7KOR, 406-453-8574. E-Mail: [n7kor@mcn.net](mailto:n7kor@mcn.net)

Web: <http://www.tlatech.com/hamfest/>

**JULY 17**

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**CO - LOVELAND** - Superfest. Larimer County Fairgrounds, 700 Railroad Ave. 8am-2pm. Talk-in: 145.115 or 146.85. Northern CO ARC, 970-352-5304

**LA - SLIDELL** - Hamfest. Ozone ARC, Ronald Riviere WB5CXJ, 504-882-5067

**NC - CARY** - Mid-Summer Swapfest. Cary Community Center, 404 Academy St., Chapel Hill Rd. & Academy St. VE Testing. Talk-in: 147.15+6. Cary ARC, POB 53, Cary, NC 27512; include SASE.

**NY - FRANKFORT** - Hamfest. Utica ARC, Bob Decker AA2CU, 315-797-6614.

E-Mail: [ktrnd@borg.com](mailto:ktrnd@borg.com)

## Component Kits From Edlie The Kit King



## Hottest Edlie Kits



Each Kit comes complete with an educational explanation of the circuit. Build these useful kits and have! Fun Too! Each Kit comes with its own PC Board.

### 1/2 and 1/4 Watt Resistor Kit 200 for \$2.95

5% + 10%

All Standard ohmages

All top Grade material (NV5801)



### Precision Resistor Kit

100 for \$1.95

All 1% Resistors,

RN55, RN60, RN65 etc. (NV5803)



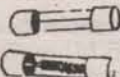
### Fuse Kit

25 for \$1.95

Primarily from

Little Fuse, & Buss

Various types included. Various amps, slow blow, standard, pigtailed etc. (NV4040)



### Crystal Kit

15 for \$1.95

Can be CB, Transmitting,

Ham. business, marine etc. (NV5815)



### Volume Control Kit

20 for \$2.95

Various ohmages to 10Meg

Some with switches. (NV5805)



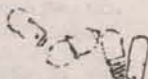
### Miniature Bulb Kit

10 for \$1.95

Can include such types as

PR6, 12, 219, 240, 222,

1847 Grain of wheat etc. (MV4041)



### IC Grab Bag

15 for \$2.50

Including 7400 Series, CMOS,

Linears, etc. All Prime All

Guaranteed (MV5808)



### LED Kit

20 for \$2.50

Different colors, Red, Green

Yellow, Different shapes (MV5811)



### Miniature

Electrolytic

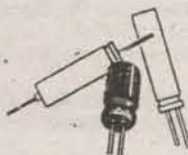
Caps

25 for \$2.95

Axial, Radial

Leads, Mixed

Capacitances, and Voltages (NV5804)



### Switch Kit

15 for \$2.95

Can be slide switches,

Rotary, Rockers, toggle

Switches. SPST,

DPDT, TPDT

All prime

(NV5818)



### #22 stranded

Wire Kit.

4 rolls 50' ea.

For \$3.95

4 assorted colors an exceptional value

(NV2736)

Also Available in 4 Rolls of 100' for \$7.95

(NV2737)



### Disc Capacitor Kit

60 for \$2.95

Various Capacitance's,

Various Voltages. NPO,

N750 etc. (NV2737)



### Hardware Kit

A mixture of screws, washers,

Nuts, Bolts, and all sorts of good

Things (approximately 300-600)

(MV5813)



### Semi Conductor Kit

25 for \$3.50

This kit contains an assortment

Of any of the following:

Triacs, SCRs, Rectifiers

Transistors (MV9561)



**\* Buy Any 5 Kits and receive A Free Resistor Kit \***

Call or Write for a

Free

76 page Catalog

800-516-645-4722

Outside the US Please send

\$3.00

Mail your orders to  
**Edlie Electronics Inc. 2700**

Hempstead Tpke

Levittown, N.Y. 11756

Order Tool Free

1-800-645-4722

In NYS 516-735-3330

Checks or Money order are accepted by mail. No C.O.D. Shipping & Handling charge \$5.00 For the continental United States All others including Canada, Hawaii, Alaska, & P.R. must pay full shipping charges.

We Accept MC, Visa, & AE

To order by Fax Call 516-731-5125

For Information Call 516-735-3330



# Events CALENDAR

**OH - WELLINGTON** - Hamfest. Lorain County Fairgrounds. 8am-2pm. VE Exams. Talk-in: 146.10/70. Northern Ohio ARS, John Shaaf KC8A0X, 216-696-5709. E-Mail: kc8a0x@qsl.net  
**PA - SALEM TOWNSHIP** - Hamfest. Beach Haven Carnival Grounds (I-80 Exit 36 or 38 N to US-11). 8am. VE Exams. Talk-in: 145.130 (PL 77.0) & 146.52 simplex. Jonestown Mountain Repeater Assn, Charlie Hooker AD3L, 570-864-2571 or fax 717-864-2377; Rich N3YGL, 570-784-0488; Mike K3EVQ, 570-752-1334; Walter N3JAD, 570-822-0180. E-Mail: chooker@epix.net  
**TX - DENISON** - North Texas Hamfest '99, Wilmer O. Kinsey WB5DCU, 903-893-5872. E-Mail: wb5dcu@gte.net  
 Web: <http://home1.gte.net/wb5dcu/nortex99.html>

JULY 18

**IL - SUGAR GROVE** - Hamfest. Waubesa Community College, Rt. 47 at Harter Rd. (5 mi NW of Aurora). 8am. VE Exams. Talk-in: W9CEQ - 147.210 (+) PL 103.5/107.2 - AFAR repeater. Fox River Radio League, James Von Olnhausen N9U2C, 630-879-3042. E-Mail: n9u2c@amsat.org  
 Web: <http://www.frl.org/hamfest.html>  
**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1xm/www/swapfest.html>  
**MO - WASHINGTON** - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 days, 314-458-3254 eves. E-Mail: Dave Neal@msn.com  
 Web: <http://zbarc.usmo.com/>  
**NJ - AUGUSTA** - Hamfest. Sussex County ARC, Dan Carter N2ERH, 973-948-6999. E-Mail: n2erh@email.com  
 Web: <http://www.scarcnj.org>  
**OH - VAN WERT** - Hamfest. Van Wert County Fairgrounds, US Rt. 127 S. 8am-3pm. VE Exams. Talk-in: 146.85 (-). Van Wert ARC, Bob Barnes WD8LPY, 419-238-1877, Bob KA8IAF, 419-795-5763. E-Mail: barnesr1@bright.net  
 Web: <http://www.bright.net/~barnesr1/w8fy.html>

JULY 23-24

**FL - MILTON** - Hamfest. Milton ARC, Dean Clark WB6UKF, 850-626-9752. E-Mail: acordc@worldnet.att.net  
**OK - OKLAHOMA CITY** - Ham Holiday '99. Oklahoma State Fair Park (Hobbies, Arts & Crafts Bldg.), intersection I-40 & I-44. 5-8pm Fri., 8am-5pm Sat. Talk-in: 146.82. Central Oklahoma Radio Amateurs, Thomas Webb WA9AFM. E-Mail: n1pn@swbell.net or tmwebb@telepath.net  
 Web: <http://www.geocities.com/heartland/7332>

JULY 23-24-25

**AZ - FLAGSTAFF** - Hamfest & ARRL AZ State Convention. Norm Martin KC7FNK, 520-297-9562. E-Mail: arcathill@aol.com  
 Web: <http://www.hamsrus.com>

JULY 24

**NH - NASHUA** - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665  
**OH - CINCINNATI** - Hamfest. OH-KY-IN ARS, Dana Laurie WA8M, 513-761-7388. E-Mail: wa8m@arri.net  
 Web: <http://www.qsl.net/k8sch>

JULY 24-25

**SD - CLEAR LAKE** - Hamfest. Deuel County ARC, Don Clifford N7AXW, 605-876-2671. E-Mail: drc@itctel.com

JULY 25

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Mary Russo 714-558-8813  
**MD - TIMONUM** - Hamfest. Timonium Fairgrounds, York Rd. off I-695, I-83. 8am. VE Exams. Talk-in: 147.030 (+) & 224.960 (-) & 448.325 (-). Baltimore Radio Amateur TV Society, 410-461-0086. E-Mail: brats@smart.net  
 Web: <http://www.smart.net/~brats>

JULY 30-31-AUGUST 1

**OR - PORTLAND** - Pacific Northwest DX Convention. Willamette Valley DX Club, Al Rovner K7AR, 360-256-7437 E-Mail: alanr@pacifier.com  
 Web: <http://www.qsl.net/wvdx>

JULY 31

**IN - HUNTINGTON** - Hamfest. Huntington County 440 Repeater Group, Ray Tackett KC9DZ, 219-786-0029 or 219-786-0057. E-Mail: rtackett@ctnet.com  
**KY - BOWLING GREEN** - Hamfest. Kentucky Colonels ARC, Fred Painter, KA4CFW, 502-842-3193. Web: <http://kcarc.premiernet.net>  
**NC - WAYNESVILLE** - Hamfest. Haywood County Fairground. Western Carolina ARC, Carl Smith N4AA, 828-683-4251. E-Mail: wcars@dxpub.com  
**NV - RENO** - Hamfest. Sierra Nevada ARC, Bill Massie K7NHP, 775-246-3756. E-Mail: macm.yncsmassie@juno.com  
**OR - BASTON** - Hamfest. Coos County ARC, Brian Howard W7MLT, 541-572-5623. E-Mail: w7mlt@usa.net

## AUGUST 1999

AUGUST 1

**IN - ANGOLA** - Hamfest. Land of Lakes ARC, Bill Brown WD9DSN, 219-475-5897. E-Mail: sharon.l.brown@gte.net  
**OH - RANDOLPH** - Hamfest. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net Web: <http://parc.portage.oh.us>  
**VA - BERRYVILLE** - Winchester Hamfest. Clarke County Ruritan Fairgrounds. 6am. VE Exams. Talk-in: 146.82 (-) W4RKC repeater. Shenandoah Valley ARC, Guy Avey W3INT, 540-678-9970; Jane Barb KD4IET, 540-955-1745.

E-Mail: ibarb@visuallink.com. Web: <http://www.vvalley.com/svarc/hamfest> or <http://www.visuallink.net/shenvalleyarc>

AUGUST 6-7

**TX - AUSTIN** - Texas State ARRL Convention. Austin ARC, Austin Repeater Org & Texas VHF-FM Society, Joe Makeever W5HS, 512-345-0800. E-Mail: jomak@ibm.net  
 Web: <http://www.repeater.org/summerfest/>

AUGUST 6-7-8

**SD - WATERTOWN** - Dakota Division Convention. Lake Area Radio Klub, Jerry Hegg N0JH, 605-886-7151. E-Mail: n0jh@dailypost.com

AUGUST 7

**CA - CHICO** - Hamfest. Golden Empire ARS,

Muriel Pope K6GSK, 530-342-4765. E-Mail: k6gsk@w6hrc.org  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**IL - CARLINVILLE** - Hamfest. Macoupin County Fairgrounds, Rt. 4, I-55 exit 60. 7am-12pm. Talk-in: 146.82- or 443.400+ 103.5PL. Macoupin County ARC, Tim Jones 217-627-2355. KA9VIV E-Mail: jester25@ctnet.net. Jim Pitchford N9LQF, E-Mail: esda@ctnet.net  
**IL - QUINCY** - Hamfest. Western Illinois ARC, Jim Funk N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: <http://www.qsl.net/s9awe>  
**ME - ST. ALBANS** - Hamfest. Snow Mobile Club. Howard WA1SBI, 207-876-3702

Continued on page 65

## PROFESSIONAL DESOLDERING with the World's Best Transportable, Totally Self-Contained Desoldering Tool



Mike Murphy - Service Center - Van Nuys CA 818-785-7805

The single best investment of repair equipment we've made. It outperforms all other desoldering tools we've used. Easier to use and least expensive.

Dick Manning - Dicks Electronics - Hartland WI 414-367-8339  
 The ease & speed of component removal greatly increases productive time. The SMD kit makes SMD removal a breeze, even for inexperienced Techs.

Don Scott - LAV Electronics - Healeah-Miami Lakes FL  
 I am a constant user of the SC7000 Desoldering Tool and for quick component removal, this unit has no equal. It also comes with excellent company support. I am very satisfied and highly recommend it to anyone in the servicing field.

George Hefner - Hefner Electronics - Coleridge NE 402-283-4333  
 Being a one-man service center, I hesitated to spend the money on a desoldering tool, however all that changed when I nearly ruined a \$400 computer logic board. It has cut my desoldering time by 50%.

Don Cressin - Certified Electronics Service - Ellicott City MD 301-461-8008  
 We have obtained excellent results with the SC7000 including repairing high density U/V tuners. It is one of the best purchases we have made.

Doug Pettit - LuRay Electronics - LuRay VA 703-743-5400  
 We found that the SC7000 not only saves money vs. wick, but saves valuable time in troubleshooting. It allows you to be more accurate in removing SMD's.

MSRP \$475.00  
 Sale Price \$395.00

**FREE TRIAL**  
 Available on Request

Price includes  
 stand worth \$25.00  
 one extra filter and  
 two tip cleaners.

Timothy Kraft - Monikraft, Inc. Cherry Hill NJ 609-751-3252  
 We replaced all our existing desoldering stations with the SC7000. Our technicians are very pleased with the improved performance, portability, and reliability over our previous higher priced equipment.

Bill Warren CET/CSM - Warrens Audio & Video - Knoxville TN 234-546-1128  
 We have been extremely satisfied with the quality and durability of the DEN-ON SC7000 as well as with after the sale support.

Keith Sabs - J & M Electronics Omaha NE 402-291-7100  
 It's a must tool for my bench. I can desolder multiple pin IC's quickly and clean. It will even take up large solder amounts on tuner and case grounds.

For More Info  
 and 5% Savings Go To

[www.howardelectronics.com/den-on/sc7000zb.html](http://www.howardelectronics.com/den-on/sc7000zb.html)

## DEN-ON SC7000Z

**Sale Price**  
**\$395.00**

### New Features

- ◆ Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- ◆ 100 Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- ◆ Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- ◆ Totally ESD Safe. The housing contains carbon and the tip is at ground potential for complete ESD Protection.

Howard Electronic Instruments, Inc.  
 6222 N. Oliver Kechi, KS 67067

### New Specifications

- ◆ Voltage — AC 100v, 120V, 230V, 50/60 HZ
- ◆ Power Consumption — 120W
- ◆ Pump — Diaphragm Type
- ◆ Motor Output — 12W
- ◆ Vacuum Attained — 650mm Hg
- ◆ Temperature Range — 300° C — 500° C (572° F — 932° F)
- ◆ Air Flow Rate — 15 Liter/Minute (Open)
- ◆ Heater — 100W (Ceramic)
- ◆ Control System — Feed Back Zero Cross-over Type
- ◆ Net Weight — 420 Grams

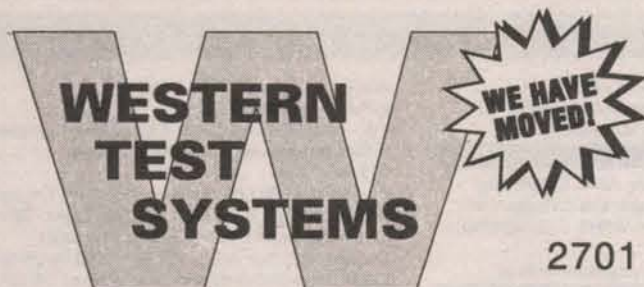
Visa - M/C - Discover - American Express - Terms to Qualifying Companies  
 30 Day Money Back Total Satisfaction Guarantee - One Year Parts and Labor Warranty

**HOWARD ELECTRONIC INSTRUMENTS INC**  
 Your Desoldering Specialists

Toll Free U.S. and Canada  
**1-800-394-1984**

[www.howardelectronics.com](http://www.howardelectronics.com)  
[sales@howardelectronics.com](mailto:sales@howardelectronics.com)  
 International (316) 744-1993  
 or Fax (316) 744-1994





# WE BUY AND SELL

Inquiries 307-635-2269 • Fax 307-635-2291

Orders 800-538-1493

2701 Westland Court, Unit B, Cheyenne, Wyoming 82001

## OSCILLOSCOPES & ACCESSORIES

### OSCILLOSCOPES

TEK 2247A 100 MHz 4-ch. Oscilloscope, w/voltsmeter & counter-timer	\$1,600.00
TEK 2465 300 MHz 4-channel Oscilloscope with 7A29, 7A29-04, 7B10, 7B15	\$2,250.00
TEK 7104 1 GHz Oscilloscope, with 7A24, 7A26, 7B80, 7B85	\$3,500.00
TEK 7844 400 MHz Dual Beam Oscilloscope with 7A24, 7A26, 7B80, 7B85	\$900.00
TEK 7904 500 MHz Oscilloscope, with 7A24, 7A26, 7B80, 7B85	\$900.00
TEK SC502 15 MHz Dual Trace Oscilloscope, TM500 series	\$375.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$375.00

### PROBES

HP 1122A Probe Power Supply	\$150.00
TEK 1101A Accessory Power Supply, for FET probes	\$200.00
TEK P6046 100 MHz Differential Probe	\$500.00
TEK P6150 9 GHz 10X/3 GHz 1X 50 Ohm Probe, SMA(m) output	\$400.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$450.00
TEK P6202A 500 MHz 10X FET Probe	\$250.00
TEK P6701 opt.02 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, ST conn.	\$175.00

### CALIBRATION

TEK SG503 Level Generator, 250 kHz-250 MHz, TM500 series	\$600.00
----------------------------------------------------------	----------

## WAVEFORM GENERATORS

### FUNCTION

HP 3310B 5 MHz Function Generator, variable phase trigger	\$350.00
HP 3312A 13 MHz Function Generator	\$500.00
HP 3314A 20 MHz Function Generator, HPIB	\$1,500.00
HP 3325A 21 MHz Synthesized Function Generator, HPIB	\$1,000.00
HP 8165A-002 Prog. Signal Source, 1 mHz-50 MHz, log sweep	\$1,750.00
HP 8904A-001,002,004 Multifunction Synthesizer, DC-600 kHz	\$2,500.00
TEK AWG5102 Arb.Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$900.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$1,250.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$275.00
TEK FG501 1 MHz Function Generator, TM500 series	\$225.00
TEK FG502 11 MHz Function Generator, TM500 series	\$300.00
TEK FG503 3 MHz Function Generator, TM500 series	\$250.00
TEK RG501 Ramp Generator, TM500 series	\$175.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB	\$750.00

### PULSE

BERKELEY NUCLEONICS 7085B Digital Delay Generator, 0-100 mS, 1 nS res., 5 Hz-5 MHz	\$750.00
HP 8007B 100 MHz Pulse Generator	\$650.00
HP 8012B 50 MHz Pulse Generator, variable transition time	\$600.00
HP 8015A-002 50 MHz Dual Output Pulse Generator, gated burst option	\$750.00
HP 8080A/81A/83A/84A 300 MHz Word Generator	\$800.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 8082A 250 MHz Dual Output Pulse Generator	\$1,250.00
HP 8112A 50 MHz Programmable Pulse Generator, HPIB	\$4,000.00
HP 8115A 50 MHz Dual Channel Pulse Generator, HPIB	\$2,750.00
HP 8116A-001 50 MHz Pulse / F unction Generator, burst & log sweep	\$3,900.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$600.00
TEK PG505 100 kHz Pulse Generator, 80 V peak, TM500 series	\$275.00
TEK PG508 50 MHz Pulse Generator, TM500 series	\$500.00
WAVETEK 802 50 MHz Pulse Generator	\$300.00

## VOLTAGE & CURRENT

### VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector	\$400.00
HP 3456A 6-1/2 Digit Voltmeter, HPIB	\$500.00
HP 3478A 5-1/2 digit Multimeter, HPIB	\$600.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$900.00
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,250.00
TEK DM5010 4-1/2 digit Multimeter, TM5000 series plug-in	\$300.00
TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in	\$225.00

### CALIBRATION

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA	\$450.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$900.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,000.00
FLUKE 731B DC Reference Standard	\$400.00
VALHALLA 2703 AC Volt.Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$1,750.00

### VOLTAGE SOURCES

HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$850.00
------------------------------------------------------------------	----------

KEITHLEY 228 Programmable Voltage/Current Source	\$2,500.00
--------------------------------------------------	------------

### CURRENT METERS & SOURCES

HP 4140B Picoammeter / DC Voltage Source, without test fixture	\$2,000.00
HP 6177C DC Current Source, to 50 V, 500 mA	\$500.00
HP 6181C DC Current Source, to 100 V, 250 mA	\$500.00
HP 6186B DC Current Source, to 300 V, 100 mA	\$300.00
HP 6186C DC Current Source, to 300 V, 100 mA	\$750.00
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance	\$500.00
KEITHLEY 227 Current Source, 1 uA-1 A, 0-50 V compliance	\$800.00
KEITHLEY 261 Picoampere Source	\$375.00
KEITHLEY 614 Electrometer	\$650.00
TEK A6303 AC/DC Current Probe, 500 Amps peak	\$850.00
TEK AM503/A6302/TM501 AC/DC Current Probe System	\$1,000.00
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A	\$375.00
TEK P6022 AC Current Probe w/termination, 935 Hz-120 MHz, 6 A pk	\$275.00
TEK P6303 Current Probe, DC-15 MHz, 10 mA-50 A/div., for AM503	\$700.00

## IMPEDANCE & COMPONENT TEST

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
BOONTON 72BD 1 MHz Capacitance Meter, 3-1/2 digit display	\$650.00
HP 4262A-101 3-1/2 digit LCR Meter, 120 Hz/1 kHz/10 kHz test, HPIB	\$1,750.00
HP 4280A-001 1 MHz C Meter / C-V Plotter; 5-1/2 digit res. C	\$3,000.00

### STANDARDS

E.S.I. SR-1 Standard Resistor, various values	\$125.00
E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step	\$550.00
E.S.I. SR1050-1M Resistance Transfer Standard, 1 Megohm/step	\$2,000.00
GR 1404-A 1000 pF Reference Standard Capacitor	\$700.00
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc.	\$375.00
GR 1432-U 4-Decade Resistor, 0-111,10 Ohms, 0.01 Ohm resolution	\$100.00
GR 1433-J 4-Decade Resistor, 0-111,10 Ohms, 0.1 Ohm resolution	\$150.00
GR 1433-K 4-Decade Resistor, 0-111,10 Ohms, 0.1 Ohm resolution	\$150.00
GR 1433-L 4-Decade Resistor, 0-111,100 Ohms, 10 Ohms resolution	\$150.00
GR 1433-N 5-Decade Resistor, n 0-111,111 Ohms, 0.1 Ohm resolution	\$200.00
GR 1433-X 6-Decade Resistor, to 111,111.0 Ohms, 0.1 Ohm res.	\$250.00
VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigaohms, GPIB	\$1,250.00

### HI & LO RESISTANCE

HP 4328A Milliohmeter	\$1,200.00
T.D.R.	
TEK 1502-opt.04 Time Domain Reflectometer, 0-2,000 feet, chart recorder	\$1,400.00
TEK 1503B-03.04 T.D.R., 0-50,000 ft., chart recorder & battery power	\$3,000.00
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$1,400.00

## POWER SUPPLIES

### SINGLEOUTPUT

GLASSMAN PS/WH-03R150XE2 0-3000 V 0-150 mA CV/CC Power Supply	\$800.00
HP 6011A Autoranging 0-20 V 0-120 A Power Supply, 1000 W max.	\$1,400.00
HP 6200B Dual Range Supply, 0-20 V 0-1.5 A/0-40 V 0-750 mA CVCC	\$200.00
HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply	\$175.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply	\$200.00
HP 6256B 0-10 V 0-20 A CV/CC Power Supply	\$250.00
HP 6260B-027 0-10 V 0-100 A CV/CC Power Supply; 208 VAC line	\$675.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply	\$400.00
HP 6269B-028 0-40 V 0-50 A CV/CC Power Supply; 230 VAC line	\$900.00
HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply	\$150.00
HP 6289A 0-40 V 0-1.5 A CV/CC Power Supply	\$200.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply	\$200.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply	\$125.00
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply	\$450.00
HP 6672A System DC Power Supply, 0-20 V 0-100 A CV/CC, HPIB	\$2,750.00
KEPCO ABC-1500M 0-1500 V 10 mA CV/CL Power Supply	\$125.00
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply	\$900.00
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply	\$375.00
LAMBDA LK-352-FM 0-60 V 0-15 A CV/CC Power Supply	\$600.00
SORENSEN DCR 20-25B2 0-20 V 0-25 A CV/CC Power Supply	\$550.00
SORENSEN DCR 600-0.75B2 0-600 V 0-750 mA CV/CC Power Supply	\$550.00

SORENSEN DCR 600-1.5B 0-600 V 0-1.5 A CV/CC Power Supply	\$700.00
SORENSEN SRL 20-12 0-20 V 0-12 A CV/CC Power Supply	\$400.00
SORENSEN SRL 60-8 0-60 V 0-8 A CV/CC Power Supply	\$600.00
TEK PS501-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series	\$175.00

### MULTIPLE OUTPUT

HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply	\$450.00
HP 6236B Triple Output Supply, to +/-20 V 0.5 A & 0-6 V 2.5 A	\$375.00
HP 6237B Triple Output Supply, to +/-20 V 0.5 A & 0-18 V 1 A	\$375.00
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply	\$450.00
HP 6255A Dual 0-20 V 0-1.5 A CV/CC Power Supply	\$450.00
KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-8V 5A	\$250.00
LAMBDA LPD-422-FM Dual 0-40 V 0-1 A CV/CC Power Supply	\$300.00
LAMBDA LPT-7202-FM Triple Output Power Supply	\$450.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$650.00
TEK PS503A Dual Power Supply, TM500 series	\$200.00

### MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max.	\$350.00
ELGAR 501C/400SD AC Power Source, 45 Hz-5 kHz, 500 VA, 0-135 VAC	\$1,150.00
HP 59501B HPIB Isolated DAC/Power Supply Programmer	\$175.00
HP 6825A Bipolar Power Supply/ Amplifier, +/- 20 V 2 A	\$800.00
KEPCO BOP 20-20M Bipolar Op Amp/Power Supply, to 20 V 20 A	\$675.00
KEPCO BOP 36-5M Bipolar Op Amp/Power Supply, to 36 V 5 A	\$400.00
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A	\$400.00
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max.	\$200.00

## TIME & FREQUENCY

### UNIVERSAL COUNTERS

HP 5314A-001 100 MHz/100 nS Universal Counter; TCXO reference option	\$275.00
HP 5315A-001 100 MHz/100 nS Universal Counter; TCXO reference option	\$450.00
HP 5315A-002,003 100 MHz/100 nS Univ. Counter; batt. power & 1 GHz C-ch.	\$650.00
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option	\$550.00
HP 5315B 100 MHz/ 100 nS Universal Counter	\$500.00
HP 5316A 100 MHz/100 nS Universal Counter, HPIB	\$600.00
HP 5316A-001,003 100 MHz/ 750.00 100 nS Univ. Counter, HPIB, TCXO, 1 GHz C-ch.	\$750.00
HP 5316B 100 MHz/ 100 nS Universal Counter, HPIB	\$750.00
HP 5364A Microwave Mixer / Detector, for modulation domain an.	\$3,000.00
TEK DC5004 Programmable 100 MHz/ 100nS Counter/Timer, TM5000 series	\$250.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$400.00
TEK DC5010 350 MHz / 3.125 nS Universal Counter, TM5000 series	\$950.00
TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series	\$275.00
TEK DC509 135 MHz/ 10 nS Universal Counter, TM500 series	\$275.00

### FREQUENCY COUNTERS

EIP 545A 18 GHz Frequency Counter	\$750.00
EIP 575 18 GHz Source Locking Counter, GPIB	\$1,250.00
FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult.	\$500.00
HP 5340A 18 GHz Frequency Counter	\$450.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference	\$3,500.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$3,500.00
TEK DP501 1.3 GHz Prescaler, divide by 16, TM500 series	\$225.00

### STANDARDS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power	\$1,500.00
HP 5061A Cesium Frequency Standard, 0.1/1.0/5.0/10.0 MHz outputs	\$6,500.00
HP 5065A-002 Rubidium Frequency Standard, 0.1/1.0/5.0/10.0 MHz out	\$3,500.00
HP 5087A Distribution Amplifier, 12 outputs at 1 MHz	\$1,500.00
HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz	\$1,750.00
HP 5087A-opt.033 Distribution Amplifier; 12 outputs at 10 MHz	\$1,750.00

## AUDIO & BASEBAND

### SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,500.00
TEK 7L5/L3/R7603 Spectrum Analyzer, 20 Hz-5 MHz, 10 Hz min. res., w/frame	\$1,500.00

### DISTORTION ANALYZERS

HP 339A Distortion Analyzer, built-in low distortion osc.	\$750.00
HP 8903A-001 Audio Analyzer, 20 Hz-100 kHz; rear panel input	\$1,500.00
TEK DA4084 Programmable Distortion Analyzer	\$750.00

### RMS VOLTMETERS

FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz	\$450.00
-----------------------------------------------------------	----------





# 90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS



## OSCILLATORS

HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP 3336C Synthesizer / Level Generator, 10 Hz-21 MHz	\$1,400.00
TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz	\$2,750.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500	\$200.00

## MISCELLANEOUS

KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$350.00
KROHN-HITE 3202 Dual HP/LP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$450.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$900.00
KROHN-HITE 3750 LP/HP/BR Filter, 0.02 Hz-20 kHz, 8/12/18/24 dB/oct.	\$600.00
KROHN-HITE DCA-10R 10 Watt Amplifier, 20 dB gain, DC-1 MHz, 600-1000	\$450.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz	\$900.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$475.00

## RF & MICROWAVE

## SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A	\$600.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz	\$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 3585A Spectrum Analyzer, 20 Hz-40 MHz, 3 Hz min. res. bw.	\$4,500.00
HP 8559A/853A-001 Spectrum An. frame, 0.01-21 GHz, 1 kHz res., w/rackmount	\$3,750.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res.	\$3,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw.	\$7,500.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L13/7L14	\$950.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz	\$1,500.00

## NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7	\$600.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz	\$1,000.00
HP 8405A Vector Voltmeter, 1-1000 MHz	\$450.00
HP 85020A Directional Bridge, 10-4300 MHz, N(f) test port	\$650.00
HP 85027C Directional Bridge, 0.01-18 GHz, N(f) test port	\$1,750.00
HP 85044A Reflection/Transmission Test Set, 300 kHz-3 GHz	\$1,500.00
HP 8756A Scalar Network Analyzer, 26.5-40.0 & 50.0-75.0 GHz outputs	\$2,500.00
HP 85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series	\$1,200.00
WILTRON 560-98KF50 SWR Autotester, 10 MHz-40 GHz, for Wiltron 560 series	\$1,800.00

## SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB	\$1,900.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res., GPIB	\$1,500.00
FLUKE 6060B/BAK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res.	\$2,250.00
GIGATRONICS 1018 Synthesized Signal Gen., 50 MHz-18 GHz, 1 MHz res.	\$4,500.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB	\$2,500.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$2,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$3,750.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res., GPIB	\$2,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$450.00
HP 3335A Synthesizer / Level Generator, 200 Hz-81 MHz	\$4,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$3,750.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation	\$1,000.00
HP 8656B-001 Synth. Signal Gen., 0.1-990 MHz, 10 Hz res., OCXO ref.	\$2,500.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HP1B	\$3,250.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A	\$2,750.00
HP 8660C/86603A Synthesizer, 1-2600 MHz, AM / FM, w/86633B	\$3,250.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output	\$6,000.00
HP 8673G-004,008 Synth. CW Signal Generator, 2-26 GHz, +8 dBm output	\$12,500.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse	\$3,500.00

## SWEEP GENERATORS

HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator	\$4,000.00
HP 8350A/83570A Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled	\$5,500.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$400.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8622B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten.	\$1,250.00
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled	\$700.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$300.00
HP 86242D-004,008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$300.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$500.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled	\$500.00

HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$500.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$1,250.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled	\$4,500.00

## POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, dBm, 75-110 GHz (WR10), -20 to +20	\$2,500.00
BOONTON 4200-01A, 03/8-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors	\$950.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor	\$375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$300.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$900.00
HP 435B/8482H Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz	\$900.00
HP 436A/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$1,400.00
HP 8477A Power Meter Calibrator, for HP 432 series	\$500.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series	\$350.00
HP R486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8	\$1,500.00

## RF MILLIVOLTMETERS

BOONTON 92B-opt.05 RF Millivoltmeter, 10 kHz-1.2 GHz, 75 Ohms scale	\$500.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00

## AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RES. 1W1000 Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output	\$650.00
BOONTON 82AD-opt.01A Modulation Meter, AM, FM, 10-1200 MHz, GPIB	\$750.00
HP 415E SWR Meter	\$200.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms	\$125.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output	\$375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$2,500.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO	\$3,000.00
HP 8970A Noise Figure Meter	\$4,000.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output	\$1,500.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz	\$5,000.00

## COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
AVANTEK AMT-400X2 WR28 Active Doubler, 13-20 GHz +10 dBm in, +10 dBm out	\$450.00
BAYTRON 3-28-300/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$300.00
BIRD 6735-300 1 k Load, 25-1000 MHz, LC(f), with wattmeter	\$650.00
CONTINENTAL MW. RAE28-K-M WR28 x K(m) Endfire Adapter	\$225.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f)	\$300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm	\$475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm	\$1,200.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port	\$450.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f)	\$150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA	\$350.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA	\$400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz	\$750.00
HP K281C-012 WR42 x APC3.5(m) Adapter	\$300.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18-26.5 GHz	\$2,900.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	\$450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz	\$275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz	\$300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HP R382A WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$2,000.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz	\$400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz	\$500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz	\$450.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz	\$450.00
HP R914B WR28 Moving Load, 26.5-40 GHz	\$250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz	\$750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz	\$650.00
HP X870A WR90 Slide Screw Tuner	\$150.00

HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz	\$900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz	\$900.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz	\$900.00
HUGHES 45721H-1000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$900.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz	\$1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	\$250.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz	\$400.00
HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz	\$800.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	\$600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm	\$2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm	\$2,750.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response	\$375.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC	\$200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
MIDWEST MICROWAVE 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) "NEW"	\$40.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)	\$25.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$300.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m)	\$500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz	\$1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz	\$1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4226-10 Directional Coupler, 10 dB, 0.5-18.0 GHz, SMA(f)	\$275.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f)	\$325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f)	\$100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f)	\$200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f)	\$200.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f)	\$135.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$165.00
NARDA 769-30 30 dB Attenuator, 150 Watts, DC-6 GHz, N	\$275.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz	\$375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)	\$50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$75.00
SPACEK LABS K-2X Frequency Doubler, 9.0-13.25 GHz in / 18.0-26.5 GHz out	\$350.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$1,000.00
TRG B528 WR22 Direct Reading Phase Shifter, 0-360 deg., 33-50 GHz	\$1,250.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	\$600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz	\$750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB	\$200.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f)	\$150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f)	\$150.00

## COMMUNICATIONS

HP 4935A-001 Transmission Test Set, 20 Hz-110 kHz, battery option	\$700.00
HP 59401A HP1B Bus Analyzer	\$700.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars	\$800.00
TEK 1411R PAL Gen., w/SPG12 sync; TSG11 color bars; TSG13 linearity	\$750.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG13, TSG15, TSG16	\$1,000.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG12, TSG13, TSG15, TSG16	\$1,100.00
TEK 1411R-opt.04 PAL Test Gen., w/SPG12, TSG11, TSG13, TSG15, TSG16	\$1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal	\$800.00
TEK 148 PAL Insertion Test Signal Generator	\$700.00
TEK 520A NTSC Vectorscope	\$750.00
TEK 521A PAL Vectorscope	\$750.00

## MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer	\$500.00
HP 7090A Measurement Plotting System	\$1,500.00
P.A.R. 5206-95, 98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB	\$1,500.00
TEK TM5006 5000-series 6-slot Programmable Power Module	\$600.00
TEK TM504 500-series 4-slot Power Module	\$175.00
TEK TM506 500-series 6-slot Power Module	\$250.00
TEK TM515 500-series 5-slot Traveller Power Module	\$275.00



# Switching Power Supply

by D. P. Roberts

*Provides Safe,  
Steady 5 Volts  
From Vehicle's  
12-Volt System*

**P**owering a 5-volt circuit (like a single-board computer or BASIC Stamp project) off a car or truck's 12-volt electrical system is not as straightforward as you might think. A poorly designed 5-volt power supply can be the death of your automotive project.

In this article, I describe vehicular power-supply problems and present a simple solution: a modular switching regulator plus a few external components that yield a safe, efficient 5-volt supply at up to 1 ampere.

If you don't need high-current output, you can use a variation on the same circuit to armor an inexpensive linear voltage regulator against vehicular power gremlins.

Let's look at the problems that make a vehicle's 12-volt system so hostile to 5-volt regulators.

## Linear Voltage Regulators Get Hot

When I need to drop some higher voltage down to 5 Vdc, I automatically reach for a three-terminal linear regulator IC like the 7805. These are cheap and easy to use, often requiring nothing more than a couple of capacitors to work (Figure 1).

In the process of reducing the input voltage, 78xx-type regulators convert excess energy to heat. When the input voltage is close to the output voltage or the current draw is low, this heating may not even be noticeable. But when the voltage and/or current is high, the regulator can get very hot.

An example: With 14 volts input and 5 volts output, there's a 9-volt drop across the 7805 regulator. If you draw 1 ampere (1A) from the circuit, the 7805 converts 9 watts (9W) of electrical energy to heat (watts = volts x amperes). This is no good; the 7805 specs say that without a heatsink, the max power (heat) dissipation for this guy is less than 2W (at an ambient temperature of 50°C/122°F, less at higher temperatures).

How much would a heatsink help? Finding out requires a little math, but it's not painful.

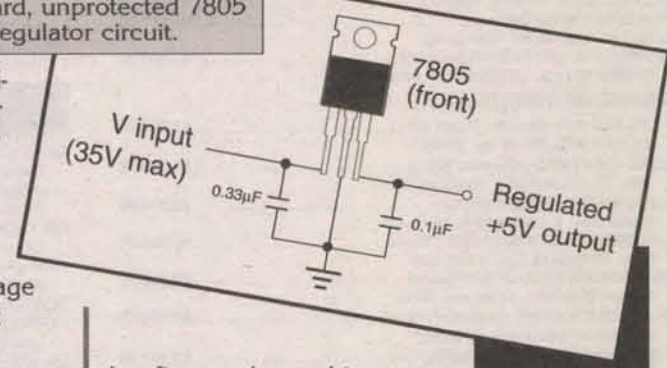
Manufacturers of power semiconductors and heatsinks publish "thermal resistance" figures for their components. To determine the temperature rise inside the component (at the semiconductor junction, where the heat originates), you add up all the thermal resistances between the junction and free air and multiply by the power. Add the temperature rise to the ambient temperature, and you've got the actual temperature inside the component.

For a 7805 in the TO-220 package, thermal resistance is 4°C/W (read "degrees Celsius per watt") from the junction to the heatsink tab. A fairly typical TO-220 heatsink has a thermal resistance of about 19°C/W to free air. There's also about a 0.5°C/W thermal resistance between the TO-220 tab and the heatsink.

Multiplying the total thermal resistance (4 + 19 + 0.5 = 23.5) by the power dissipation (9W) gives the temperature rise in °C, 23.5 x 9 = 211.5°C. Actual temperature at the junction is

**FIGURE 1.**

Standard, unprotected 7805 regulator circuit.



that figure, plus ambient temperature; 211.5 + 50°C = 261.5°C (502.7°F).

Now the bad news. The max junction temperature for the 7805 is 150°C. The heatsink isn't enough to make our automotive 7805 application work.

You can recalculate these figures with larger heatsinks until you find one that will work, but it's often a losing proposition.

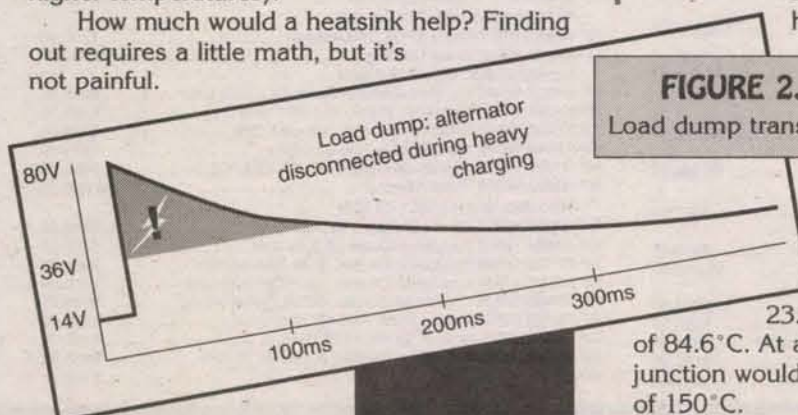
Should we forget about the 7805 altogether? Not necessarily. Remember the role that current plays in the generation of heat. Less current means fewer watts means cooler components.

If the current drawn from the 7805 averages 0.4A (400 milliamperes; mA) or less, the power dissipation becomes 3.6W or less.

Multiply that by the small heatsink thermal resistance of 23.5 and you get a temperature rise of 84.6°C. At an ambient temp of 50°C, the junction would be 134.6°C, just within the max of 150°C.

**FIGURE 2.**

Load dump transient.





## Switching Voltage Regulators Stay Cool

Linear voltage regulators like the 7805 get hot because they are obliged to do something with the electrical energy that's drawn from the input but not delivered to the output. What they do is convert that energy to heat.

Switching regulators attack the problem differently. As the name implies, they switch on and off, applying the input voltage to an inductor, which stores the energy in its magnetic field. Control electronics vary the proportion of switch on and off time to regulate the output voltage to a desired level. An output capacitor smooths out the ripple caused by the switching.

The advantage of this approach is that there's very little voltage drop across the switching element. Since power (watts) = volts x amperes, low voltage drop means very little power converted to heat.

Hobbyists tend to avoid switching supplies. The math required to design them, the parts required to build them, and the careful construction required to make them work properly are all a little intimidating. As we'll see later, a neat little module solves all of these problems and allows us to use a professionally designed switcher in our vehicular application.

Before we get to the circuit, let's look at the other problem with vehicle power systems.

## Vehicular Electrical Spikes and Surges

Take a look at Figures 2, 3, and 4. These graphs (based on illustrations from the excellent book *The Circuit Designer's Companion*, by Tim Williams, Newnes/Butterworth Heinemann) are a rogues' gallery of surge and spike conditions that routinely occur in a car's electrical system.

Any electronic device that draws power from the car battery must be protected against these nasties. I've shaded portions of each graph to indicate the conditions that violate the operating conditions for the 7805 (and most other voltage regulators). If the voltage regulator isn't protected, it will eventually fail, possibly subjecting the 5-volt devices downstream to 14 volts, and probably incinerating them faster than a fuse can blow.

From the graphs, we can see that there are basically two problems: reversed polarity (from inductive switching and field decay), and over-voltage (load dump). Fortunately, neither of these conditions last very long; less than a tenth of a second, worst case.

## Application-Note Inspired Circuit

When I set out to design my power-supply circuit, I knew I wanted to use a switching regulator to avoid having a sizzling-hot heatsink somewhere under the dashboard. I also knew that I didn't want to design a switcher. Consulting the Digi-Key catalog, I found that a company called Power Trends makes a series of switching regulator modules designed to replace linear 7805s in many applications. Perfect!

Even better, at the Power Trends web site ([www.powertrends.com](http://www.powertrends.com)), I found an application note called "Vehicular Power Adapter Using ISRs (integrated switching regulators)." I took their design suggestions, made a couple of minor improvements, and built the circuit shown in Figure 5.

The circuit is designed so that you can use either a 7805 linear regulator or the Power Trends 78ST105HC integrated switching regulator. Note that I've provided two parts lists, since slightly different component values are required depending on which way you go.

Most of the components in my circuit are simply insurance against various kinds of misbehavior of the vehicle electrical system and/or regulator components. Diode D1 blocks negative spikes, while D2 (a zener diode) clips off positive spikes exceeding 36 volts. Capacitor C2 is the only one required for proper operation of the 78ST105HC, but Power Trends recommends the input capacitor (C1) to prevent switching noise from being coupled back into the vehicle's electrical system (possibly fouling up radio reception, etc.).

I added the small-value cap C3 after a little poking around with an oscilloscope. I wasn't happy with the amount of ripple on the output (about 400 millivolts; mV), so I added a 0.1µF ceramic cap across the output. The ripple dropped to less than 100mV. Power Trends says that higher-value ceramic caps (1µF or more) can further reduce ripple,

FIGURE 3.

Inductive switching transient.

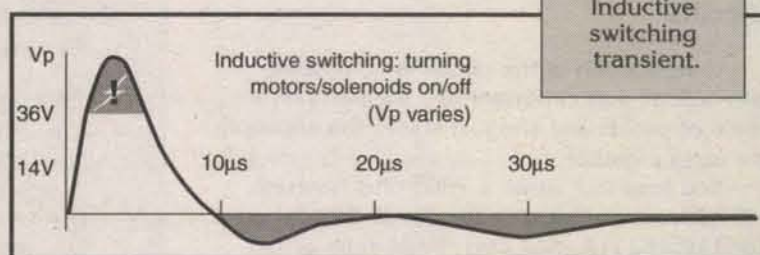


FIGURE 4.

Alternator field decay.

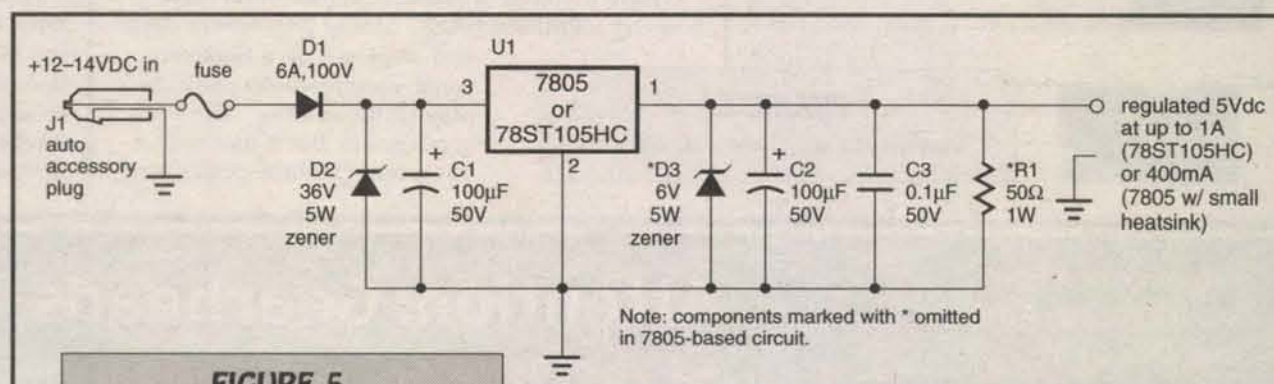
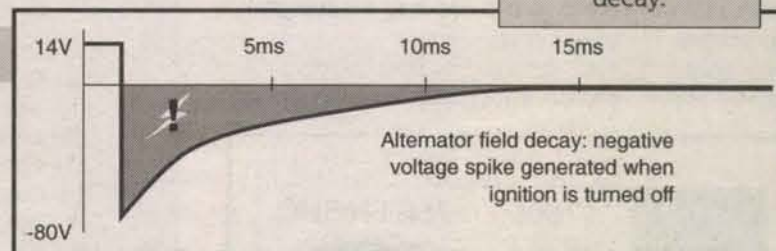


FIGURE 5.

Vehicular power supply circuit.

but such caps are not common, and 100mV ripple is acceptable for digital applications.

I added zener diode D3 to clip off any spikes that might exceed 6 volts on the output. This diode is shown in the Digi-Key application diagrams for the 78ST105HC, but not in the Power Trends documentation. Either way, if the regulator were to somehow fail with a short-circuit from input to output, the 6-volt zener diode would conduct and help to blow the fuse. A dollar well spent.

My last added component is R1. Typical of many switching regulators, the 78ST105HC requires a certain minimum current draw in order to remain in regulation. Otherwise, its output voltage could rise beyond the specified 5 volts. That minimum is 100 mA. R1 draws 100mA at 5 volts so, even with the load disconnected, the output will remain in regulation. If the load is such that it never draws less than 100mA, R1 can be omitted.

To connect my creation to the vehicle electrical system, I opted for a cigarette-lighter plug. It came with a 5A fuse, but I substituted a 2A unit. Changing the fuse is just a matter of unscrewing the knurled nose cone of the plug. A nice feature of the plug specified in the parts list is that it has a built-in power LED. If the ignition is off, the fuse is blown, or the plug isn't properly seated in the lighter jack, the LED remains dark.

*Linear voltage regulators  
like the 7805 get hot  
because they are obliged to  
do something with the elec-  
trical energy that's drawn  
from the input but not  
delivered to the output.*



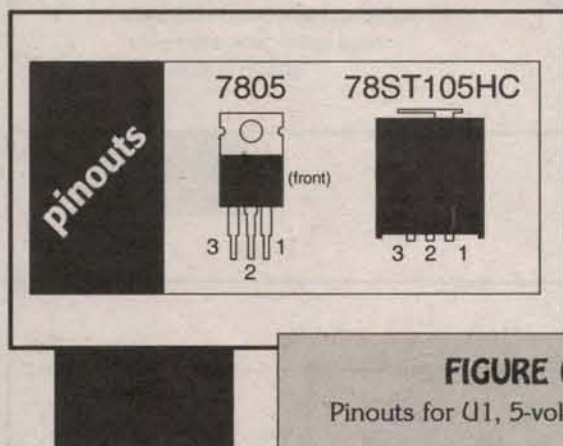
## Building and Using the Supply Circuit

Construction of the circuit is completely non-critical; you can assemble the parts on a piece of perf board and just solder the appropriate wires together.

You may use either a 7805 plus heatsink (400mA max output) or the Power Trends 78ST105HC (1A max out). Make sure to use the parts from the appropriate parts list. If you use the 7805, make sure to use a heatsink, and position the supply in a location where there's free air circulation.

I strongly recommend that you use a fuse in series with the +12V input to the supply. Depending on which circuit you tap for the input, the vehicle's fuses are probably rated too high (10A or more) to provide any meaningful protection for your circuit.

That's all there is to it. For me, building this power supply was an important stepping stone.



**FIGURE 6.**

Pinouts for U1, 5-volt regulators.

## Parts List 1: Switching Supply (1A output)

All part numbers refer to Digi-Key (1-800-digikey or www.digikey.com)

C1,C2—100µF, 50V electrolytic capacitor (part no. P1353-ND)  
C3—0.1µF, 50V monolithic ceramic capacitor (part no. P4923-ND)  
D1—silicon rectifier diode, 6A, 100V (part no. 6A1MSCT). Note: it's permissible to use a smaller diode, 2A or more.  
D2—zener diode, 36V ±5%, 5W (part no. 1N5365BMSCT)  
D3—zener diode, 6V ±5%, 5W (part no. 1N5340BMSCT)  
J1—Auto accessory (cigarette lighter) plug (part no. ZA5073-ND)  
R1—50-ohm, 1W resistor (part no. ALSR1F-50-ND)  
U1—5V, 1.5A integrated switching regulator (part no. 78ST105HC)  
fuse—2A, 250V normal-blow fuse (part no. F119-ND)

## Parts List 2: Linear Supply (400mA output)

All part numbers refer to Digi-Key (1-800-digikey or www.digikey.com)

C1,C2—100µF, 50V electrolytic capacitor (part no. P1353-ND)  
C3—0.1µF, 50V monolithic ceramic capacitor (part no. P4923-ND)  
D1—silicon rectifier diode, 6A, 100V (part no. 6A1MSCT)  
D2—zener diode, 36V ±5%, 5W (part no. 1N5365BMSCT)  
D3—zener diode, 6V ±5%, 5W (part no. 1N5340BMSCT)  
J1—Auto accessory (cigarette lighter) plug (part no. ZA5073-ND)  
R1—not used  
U1—5V, 1.0A linear voltage regulator (part no. NJM7805FA-ND)  
Heatsink—aluminum heatsink, bolt to U1 (part no. HS191-ND)  
fuse—1A, 250V normal-blow fuse (part no. F115-ND)

I have a bunch of projects in mind that involve using a Parallax BASIC Stamp II to collect data and display it on a Seetron serial vacuum-fluorescent display (VFD) module. The VFD is gorgeous, but it draws a lot of current (500mA peak), and

it's fairly expensive (\$159.00; www.seetron.com). Rather than risk destroying the module with a crummy power supply, I decided to build this project. I'm happy to report that the module has been running for weeks off the switching (78ST105HC) version of this project without a hiccup. **NV**

We accept Visa,  
Mastercard, AmEx,  
and Discover

## Attention: Gearheads

www.shrevesystems.com

To Order Call 1-800-227-3971

Fax: 318-424-9771



**PowerMac 7200**  
75 Mhz PPC 601  
4 168 pin DIMM slots  
Build your own Mac!  
**\$99 Brand New!**



**Peltier Junction**  
with heat sink  
1 3/16" x 1 3/16"  
**\$10 each or 3 for \$25**



**Texas Instruments**  
Color Composite  
Display  
Great for Surveillance  
**Refurbished \$99**



**Apple IIE Logic Board**  
**\$19**



**LC Power Supply**  
+5V, -5V, +12V Output  
**\$5 New**

## Global Village Bronze

External Modem  
2400 Bps/9600 Fax  
**\$1 Each**



## CMS Tower SCSI Case

Holds 4 5.25 full height drives  
**\$99**



### Logic Boards

Q610 Logic **\$99**  
Q660 Av Logic  
Q650 Logic  
Q800 Logic  
Q840 Logic  
**No Processor**



**MacAlly ADB Keyboard**



**\$10**

**PDA Genuine**  
Leather Carry  
Case  
Let your palm  
pilot lead the life  
of luxury!

### Power Supplies

Apple IIE \$59  
Apple IIGS \$69  
Mac IICX, Ci \$99  
Mac II, X, FX \$49  
Mac IISi \$49  
Q610, 660AV, 6100 \$149

### Newton 130

Without Lid **\$199**  
Newton Carry Bags \$19  
Newton Fax Modems \$19  
16 MB Flash Cards \$79  
20 MB Flash Cards \$99  
24 MB Flash Cards \$129

### RAM

1 MB 30 Pin 4 For \$1  
4 MB 72 Pin 2 For \$5



**Claris Works**  
3.0 For  
PC/Mac  
EDOCS **\$29**

### Miscellaneous

Apple 8 bit Video Card \$19  
LaserWriter IINT \$299  
Apple ADB Keyboard \$19  
1.44 Super Drive \$49  
Clone ADB Mouse II \$19  
Quicktake 100 Camera \$149  
Bernoulli 90 MB EXT \$10



**Membrane**  
Track Pad for  
laptop **\$2**

**\$25 minimum**  
order

**Shreve Systems**  
1200 Marshall st  
Shreveport, La 71101

Returns subject to a 15% restocking fee.  
Prices are subject to change without notice. We accept Visa,  
Mastercard, AmEx, Discover



# THE 'OPTO' IN OPTOELECTRONICS (Part 4)

The first three episodes of this mini-series described the basic nature, behavior and applications of light and light-beam manipulators such as mirrors, prisms, lenses, and fiber optic cables, with particular regard to their use in modern optoelectronic systems. This month's concluding episode describes the basic (atomic level) operating principles of LEDs and lasers, with particular emphasis on modern laser diodes.

## LEDs and LASERS

### INTRODUCTION

The two basic types of light-generating devices most widely used in modern optoelectronics are the LED and the laser. (The word LASER is an acronym for Light Amplification by Stimulated Emission of Radiation.)

LEDs and lasers differ in two major respects. First, the LED is a semiconductor device that emits light as a consequence of a current-in, photons-out power conversion process, whereas the laser is a tuned-cavity resonator device that may use a gas, liquid, or solid substance as its active medium and emits light as a result of a photon multiplication process.

The second major difference between the two types of devices is that the LED emits broad-band light in which its photons are randomly-generated and are not directly phase-related, whereas the laser emits a stimulated narrow-band coherent type of light in which its emitted photons are — at the moment of their birth — of the same wavelength and phase as their parent photons.

Because of its coherence, the laser light can be focused into a far smaller spot than that of a LED, thus enabling it to generate very high local power densities. A perfect 0.5mW IR laser beam can, for example, be focused into a minute spot measuring only 1.6µm in width (roughly equal to 1/30th of the width of a human hair), in which the IR power density has a value of about 12kW/cm<sup>2</sup> within the focused area.

To begin to understand the basic light-generating principles of LEDs and lasers, it is necessary to first learn some basic facts about the nature of atoms and about photon generation, as follows.

### ATOM AND PHOTON BASICS

All solids, liquids, and gases are

composed of chemical elements, of which there are 109 different known kinds. Each of these elements are made up from clusters, chains, or lattices of atoms, and the atom is thus the basic building block of all matter.

All atoms take the basic form illustrated in Figure 1 and consist of a positively-charged central nucleus (made up of protons and neutrons) that is surrounded by a number of bands of orbiting negatively-charged electrons. Normally, the positive nucleus charge and the negative electron charge balance one another, thus giving the atom a neutral overall charge; the atom is said to be *stable* under this condition.

Within the atom, each orbiting electron has a finite kinetic energy value, which determines the distance of its band's orbit from the central nucleus; the individual electron bands are thus known as *energy bands*; their energy is measured in electron-Volt (eV) units. Electrons orbiting in energy bands close to the central nucleus have lower energy values than those in the outer bands. The atom's outer electron-occupied energy band is known as the *valence band*.

Beyond the atom's valence band lays a normally-empty high-energy *conduction band*. If an electron that is orbiting in the valence

band gains enough extra energy, it moves upward into the conduction band but, as it does so, it leaves behind a positively-charged *hole* in the valence band; the energy-gain process thus creates an electron-hole pair. The atom is said to be in a *quasi-stable* or *excited* state under this condition. When the

**Ray describes the basic operating principles of LEDs and lasers in this final episode of the series.**

atom is in this excited state, an electron will readily move downward from the conduction band into the

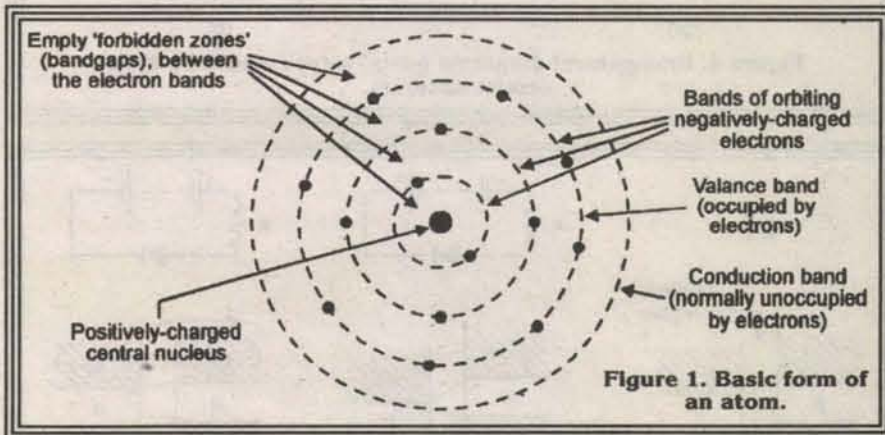


Figure 1. Basic form of an atom.

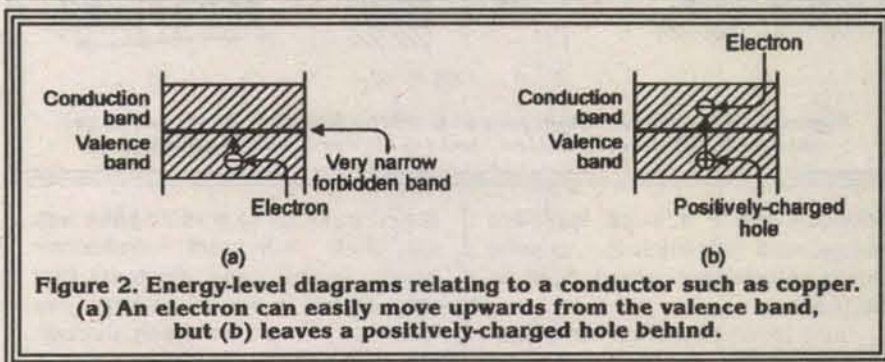
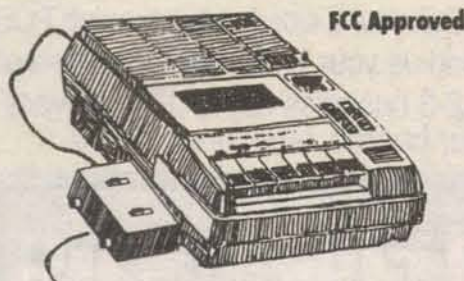


Figure 2. Energy-level diagrams relating to a conductor such as copper. (a) An electron can easily move upwards from the valence band, but (b) leaves a positively-charged hole.

## TELEPHONE LISTENING DEVICE WITH 12 HR. RECORDER



Record telephone conversations in your office or home. Starts automatically when phone is answered, records both sides of phone conversation. Recorder stops when phone is hung up. \$99.95 + \$7 shipping. For telephone listening device separately \$19.95 + \$2 ship.

For comprehensive 50 page catalog of Micro Video, VHF transmitters, Surveillance, and Counter-surveillance and much more! Send \$3.00

Call 407-725-1000

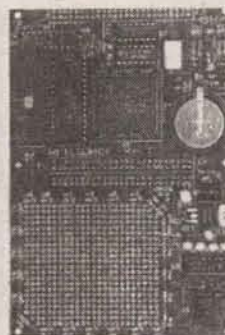
**USI CORP**

P.O. Box N2052 Melbourne, FL 32902  
COD'S OK

## MORE POWER!

68HC11, 80C51 & 80C166

AM Research supports over 30 of the most popular Embedded controllers with both *hardware* and *software*.



- ✓ More Microcontrollers
- ✓ Faster Hardware.
- ✓ Faster Software.
- ✓ More Productive.
- ✓ More Tools & Utilities.
- ✓ IIC Peripherals.
- ✓ Single Chip Capable.
- ✓ Outstanding Support.
- ✓ Custom designs.

Call or email for a free full line brochure

Orders (800) 949-8051  
Info (916) 652-7472  
fax (916) 652-6642  
www.amresearch.com

**AM Research, Inc.**  
PO Box 43  
Loomis, CA 95650

The Embedded Controller Experts



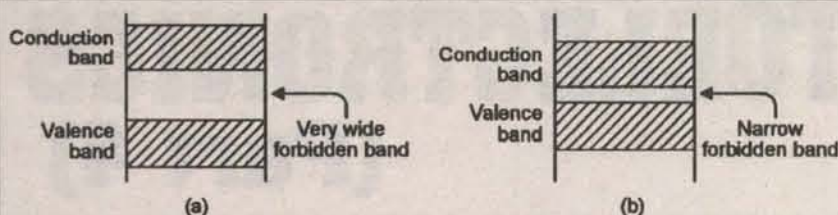


Figure 3. Energy-level diagrams relating to (a) a typical electrical insulator and (b) a typical semiconductor.

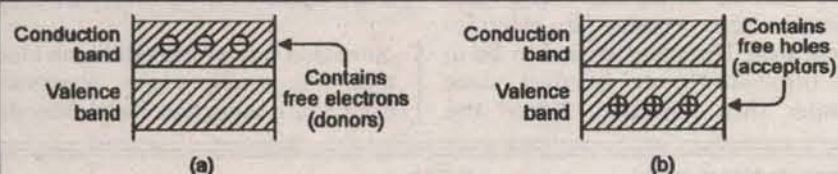


Figure 4. Energy-level diagrams for (a) n-type and (b) p-type semiconductors.

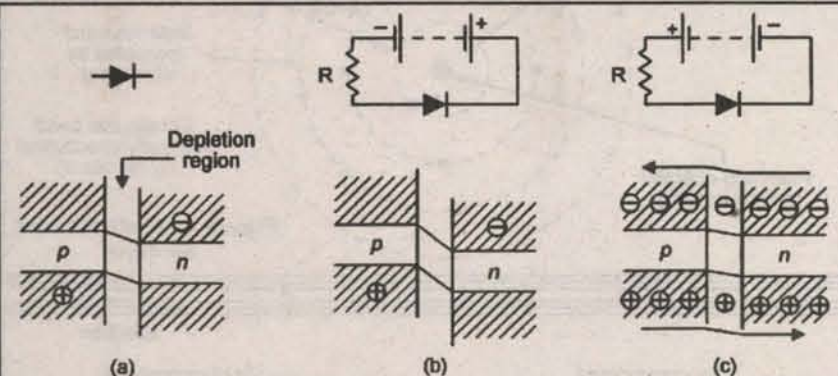


Figure 6. Energy-level diagrams of a silicon junction diode under (a) unbiased, (b) reverse biased, and (c) forward biased conditions.

valence band if it loses sufficient energy, and annihilates the valence band's positively-charged hole in the process.

In a piece of matter composed of many atoms, the atoms may be

linked together in a matrix-like way via their individual conduction bands. In this case, electrons that are not tied to specific atoms (*free electrons*) may travel freely through the material via the linked conduc-

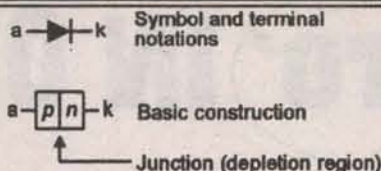


Figure 5. Symbol and basic construction of a silicon junction diode.

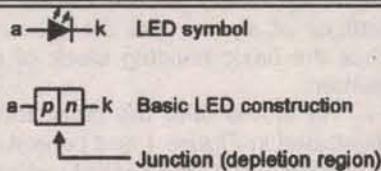


Figure 7. Symbol and basic construction of a conventional LED.

tion bands.

The spaces between the atom's energy bands are known as *forbidden zones* or *bandgaps*. Electrons can not exist in forbidden zones, but can — if subjected to sufficient energy change — jump through them to reach an adjacent energy band. When an electron jumps downwards through a bandgap (from the conduction band to the valence band), it loses an amount of energy equal to the difference between the two energy band eV values, and this loss is accompanied by the emission of a sub-atomic particle (such as a phonon or photon) with an identical energy value.

From the optoelectronics point of view, all useful photon and electron activity takes place in the vicinity of the atom's valence and conduction bands, and all such activity can thus be represented by simple

energy-level diagrams such as those shown in Figures 2 and 3, each of which depicts a narrow 'slice' section taken through the two bands.

Figure 2(a) shows the basic energy-level diagram of an atom of a conductive material such as copper. Here, the forbidden zone is so narrow that the valence and conduction bands almost merge into one another, and electrons can — under the influence of an external potential — easily move into the conduction band from the valence band, in which case, the vacated valence position is filled by a positively-charged hole, as shown in Figure 2(b).

Once the electron enters the conduction band, it is no longer bound to the atom, and is free to travel through the conductive material (via the linked outer bands of adjacent atoms) as an electric current.

Figure 3(a) shows the energy-level diagram of an atom of a typical insulation material. Here, the forbidden zone is very wide, thus blocking the flow of electrons into the conduction band and preventing the flow of current through the material. Finally, Figure 3(b) shows the energy-level diagram of an intrinsic (naturally-occurring) semiconductor material such as silicon, which has a narrow forbidden zone and thus has conduction characteristics mid-way between those of a conductor and an insulator. Unlike a normal conductor, however, the semiconductor's resistance has a negative (rather than positive) temperature coefficient.

## LED OPERATING PRINCIPLES

Conventional LEDs work in the same basic way as normal silicon junction diodes, but use special semiconductor materials to produce the light-emitting diode's photon-generating characteristics.

Silicon junction diodes are based on two different extrinsic (artificially modified) types of crystalline silicon; one type is very lightly doped with a material such as phosphorus, which has the effect of adding a number of spare electrons (*donors*) to the conduction band of the silicon's crystal lattice, as shown in the material's energy-level diagram of Figure 4(a); this material is known as an *n-type* semiconductor, since it carries an excess negative charge. The other type of silicon is lightly doped with boron, which has the effect of adding a number of spare holes (*acceptors*) to the valence band of the silicon lattice, as shown in the energy-level diagram of Figure 4(b); this material is known as a *p-type* semiconductor, since it carries an excess positive charge.

In a junction diode, the *n-type* and *p-type* materials are fused

## COMPUTER PARTS

www.lapazusa.com

### MEMORY UPGRADES

1Mx9-70 SIMM.....	\$10
4Mx9-70 SIMM.....	\$19
1Mx32/36-70 72-pin SIMM (4MB).....	\$10/15
2Mx32/36-70 72-pin SIMM (8MB).....	\$19/25
4Mx32/36-70 72-pin SIMM (16MB).....	\$35/49
8Mx32/36-70 72-pin SIMM (32MB).....	\$65/80
64M(8x64) SDRAM / PC 100.....	\$75/78

### VIDEO

1MB KIT (2-256x16) 2CAS SO/JZIP.....	\$18/35
1MB KIT (2-256x16) 2WE SO/JZIP.....	\$19/36

### CACHE

64Kx1-15ns 22-DIP.....	\$5.50
32Kx8-25/20/15ns 28-DIP.....	\$3/2/2.50
64Kx8-15ns 32-DIP.....	\$6
128Kx8-15/20ns 32-DIP narrow.....	\$12 & up
128Kx8-15/20/25ns 32-DIP wide.....	\$12 & up

### CPU

INTEL 486DX2-66 (5v) CPU.....	\$25
INTEL 486DX4-100 (5v kit) CPU.....	\$55
INTEL PENTIUM 83Mhz OVERDRIVE.....	\$75
INTEL PENTIUM 133/166 CPU.....	\$45/50

### MISC.

LBA CARD. Upgrade your hard drive beyond 540MB without the expense of a new Bios. \$29.95

486DX4 KIT. Upgrade your old 5V 486 CPU with this kit: AMD DX4-100 CPU+5v Adaptor+CPU Fan. \$65.00

MMX ADAPTOR. Allows 3v Pentium boards to accept MMX CPU. Adaptor for Intel or Cyrex CPU. \$30.00

### PENTIUM MOTHERBOARD/SYSTEMS SPECIALS

Pentium M/B 133Mhz Intel, 512K, 32MB RAM. \$195.00

Pentium II - Intel Celeron 300A, ATX M/B, 1.44 FDD, 2GB HD, 8MB Video, 56K Fax Modem, 36X CD ROM, Mid tower ATX case. Best value! \$595.00

\*\*\*1-YEAR WARRANTY ON PARTS & LABOR\*\*\*

## PACKARD BELL

486 to Pentium motherboards

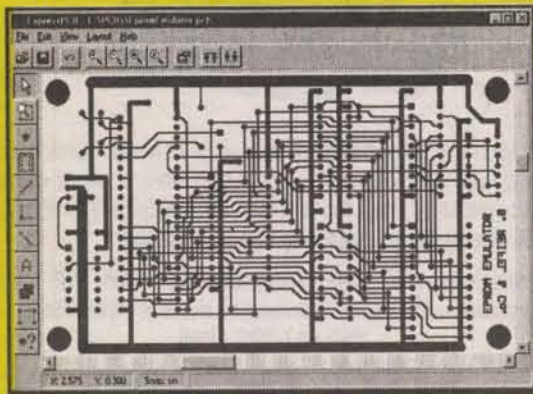
PRICES SUBJECT TO CHANGE WITHOUT NOTICE - TERMS:  
VISA/MC - MINIMUM ORDER \$20 - SHIPPING & HANDLING: \$7 MIN.  
ORDER LINE: (800) 586-4199

LA PAZ ELECTRONICS INT'L  
P.O. BOX 261095, San Diego CA 92196  
TEL (619) 586-7610 FAX (619) 586-1482  
e-mail: lapazusa@pobox.com

## PCB LAYOUT

Software For Win95 - FREE

- 1 Download our board layout software
- 2 Design your 2 sided plated-through PCB
- 3 Send us your layout over the Internet
- 4 In 2-3 business days, UPS delivers your boards, often under \$100



www.expresspcb.com



together in the manner indicated in the greatly simplified diagram of Figure 5, which also shows the diode's circuit symbol. Since both halves of the diode are made from the same basic material (silicon), the device is often called a *homojunction* diode. Figure 6 shows the diode's energy-level diagrams under (a) unbiased, (b) reverse biased, and (c) forward biased conditions. In these diagrams, the junction between the *n*-type and *p*-type materials is named the *depletion* region.

The energy level of the junction diode's positively-charged *p*-type material is inherently higher than that of the negatively-charged *n*-type material, as shown in Figure 6(a). Consequently, if the diode is reverse biased as shown in Figure 6(b), the energy level difference between the *p*-type and *n*-type material becomes even greater, inhibiting any significant flow of electrons or holes between the two materials via the depletion region.

Under this reverse-biased condition, the only currents that flow through the diode are small temperature-sensitive leakage ones and (if the junction is directly exposed to an external light source) small photon-induced currents.

Alternatively, if the diode is forward biased as shown in Figure 6(c), the energy level difference between the *p*-type and *n*-type material falls to near-zero at a forward bias value of about 0.6V, enabling electrons and holes to flow freely between the two materials via the depletion region. An electric current thus flows through the forward biased junction; it actually flows through the covalence bands (valence bands that are linked in adjacent atoms) within the silicon matrix, and often generates a phonon particle at the moment of exchange; the phonon energy is dissipated within the crystal lattice as vibrant heat.

Conventional LEDs use the same basic homojunction form of construction and work in the same basic way as normal junction diodes, but use special semiconductor materials (rather than silicon) that emit photons (rather than phonons) when forward current flows through the material's lattice. Figure 7 shows the circuit symbol and the basic construction of a conventional LED, and Figure 8 shows the LED's energy-level diagram under forward biased operating conditions.

In Figure 8, when current is flowing through the forward biased junction, most free electrons and free holes travel through the depletion (junction) area in the normal way, but some electrons don't have enough energy to stay in the con-

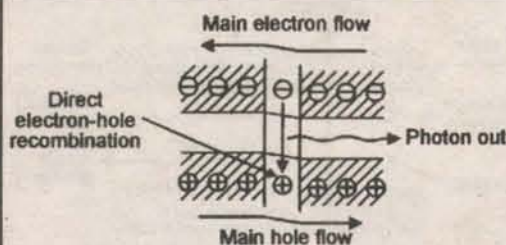


Figure 8. Energy-level diagram of a conventional LED under forward biased operating conditions.

duction band and drop down (via the forbidden bandgap zones of individual atoms) into the valence band and annihilate a hole.

The electron energy lost in this process is converted into a photon, which is radiated from the LED as a light particle. LED electrical power-in to optical power-out conversion efficiency is low, typically in the range 0.01% to 1.5%, and is greatly influenced by the photon's wavelength.

The LED's photon wavelength,  $\lambda$  (in nm) is dictated by the bandgap energy (eV, = the difference between the valence and conduction band energy values) of the LED's semiconductor material, and these two parameters are related by the easily-remembered formula  $\lambda = 1240/\text{eV}$ , and  $\text{eV} = 1240/\lambda$ . Thus, a LED that generates a red output at a wavelength of 645nm has a bandgap energy value of 1.92 eV.

Figure 9 shows some practical LED wavelength/bandgap-energy relationships together with basic details of the types of semiconductor material used to make various LEDs. The basic semiconductor material determines the

Semiconductor material	LED color	Wavelength $\lambda$ (nm)	Bandgap energy (eV)
Gallium Nitrogen (GaN)	Blue	430	2.88
Silicon Carbide (SiC)	Blue	480	2.58
Gallium Phosphide (GaP)	Green	565	2.19
Aluminum Gallium Phosphide (AlGaP)	Yellow	595	2.08
Aluminum Gallium Phosphide (AlGaP)	Orange	620	2.00
Aluminum Gallium Arsenide (AlGaAs)	Red	645	1.92
Gallium Aluminum Arsenide (GaAlAs)	Infrared	880	1.41
Gallium Arsenide (GaAs)	Infrared	950	1.31

Figure 9. Table of LED wavelength/bandgap-energy relationships.

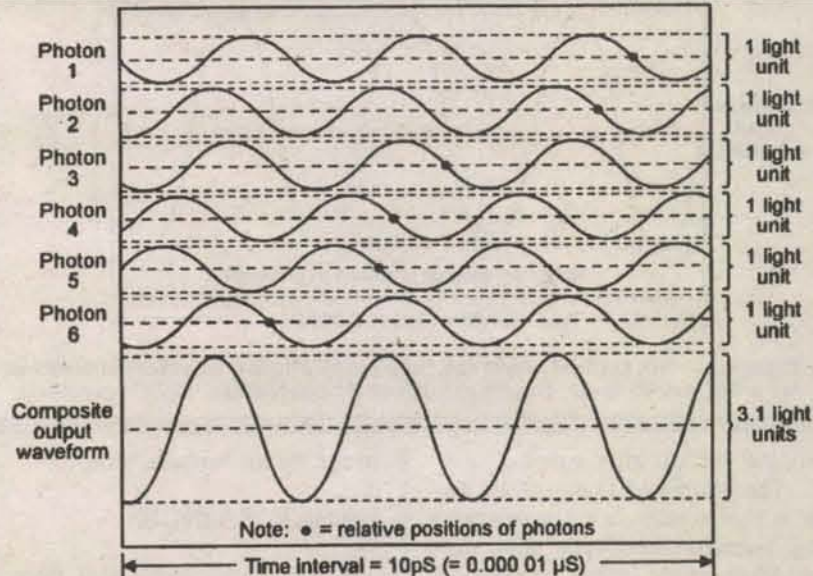


Figure 10. Six typical random (spontaneous) photon waveforms emitted by a 850nm IR LED, together with their composite 'light' waveform.

approximate energy value of the bandgap; the actual value is fine-tuned by suitably doping the material.

Note that the bandgap values quoted in Figure 9 are 'mean' (rather than absolute) ones. In reality, the bandgap energy of an atom is not fixed, but varies from moment

to moment, depending on the instantaneous depths of individual electrons within its valence-conduction bands. These energy variations are fairly small (usually within  $\pm 2\%$  of mean), but (since a photon's wavelength is directly related to bandgap energy) cause the LED's output to have a finite 'minimum

## BIG POWER LOW COST



Dominoes are rugged, miniature encapsulated controllers that combine lots of analog and digital I/O with a fast control-oriented floating-point BASIC to provide a one-stop computation and control solution for cost-sensitive control tasks. Used stand alone or connected via RS-232/RS-485, Dominoes are true plug-and-go control.

### Domino 1 features:

- Full floating-point ROMed BASIC
- 32-KB SRAM and 32-KB EEPROM
- 12 bits of parallel I/O
- 2 PWM outputs
- I<sup>2</sup>C bus
- 2-channel 12-bit ADC
- Serial port: 19.2-kbps RS-232A, RS-422, or RS-485
- +5 V @ 15 mA

### Domino 2 has:

- everything in Domino 1 plus
- 16 more bits of high-current parallel I/O
- Hardware clock/calendar
- Wide-range power operation
- Hardware PWM output

**\$99 to \$139**

Visit our Web site for complete datasheets

**www.micromint.com**

To Order Call: **1-800-635-3355**



4 Park St., Vernon, CT 06066  
(860) 871-6170

Write in 41 on Reader Service Card.

## PIC'n Books

### LEARN ABOUT PIC MICROCONTROLLERS

**EASY PIC'n - Beginner** \$29.95

**PIC'n Up The Pace - Intermediate** \$34.95

**NEW!**

**PIC'n Techniques - Intermediate** \$34.95

- 8-pin PICs
- Timer 1, timer 2 and the capture/compare/PWM (CCP) module
- Talking to a PIC with a PC using a terminal program
- Test equipment and data logger experiments

See Table Of Contents: <http://www.sq-1.com>  
Secure Online Ordering Is Available

+ \$4 s/h in US for 1 book, \$5 for 2 books, \$6 for 3 books  
VISA, MC, AMEX, MO, Check  
CA residents please add 7.25% CA sales tax  
PIC and MPLAB are trademarks of Microchip Technology Inc.

**SQUARE 1 ELECTRONICS**

P.O. Box 501, Kelseyville, CA 95451  
Voice (707) 279-8881 FAX (707) 279-8883  
<http://www.sq-1.com>  
E-Mail [sqone@pacifi.net](mailto:sqone@pacifi.net)



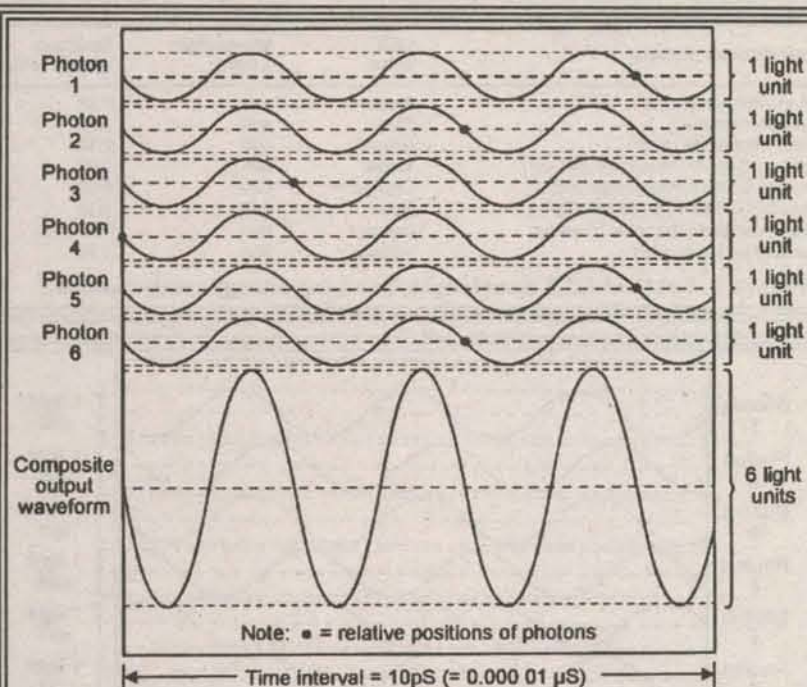


Figure 11. Six typical coherent (in-phase) photon waveforms emitted by a 850nm IR laser, together with their composite 'light' waveform.

spectral bandwidth' value.

The simple LED described earlier in this section is a surface-emitting homojunction type that uses the same basic material on both sides of its junction. In practice, many modern LEDs use different materials on the two junction sides, and are thus known as heterojunction LEDs; most such LEDs have two-stage internal junctions, and are known as double-heterojunction LEDs. Some special LEDs (designed to easily interface with fiber optic cables) are 'edge-emitting' types that emit a narrow beam of light from the side of the semiconductor material, rather than a

broad beam from its face.

## LASER BASICS

LEDs emit individual photons in a quite random or *spontaneous* fashion, whereas lasers emit photons in a *stimulated* fashion in which the birth of each new photon occurs on the arrival of a parent photon. In a laser, each new photon is — at the moment of its birth — a duplicate of its parent photon, with the same basic wavelength and (more importantly) an identical phase. Light composed of in-phase photons is known as *coherent* light, and can be focused far more

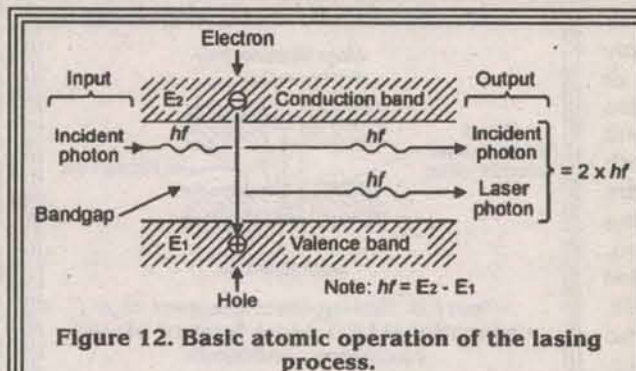


Figure 12. Basic atomic operation of the lasing process.

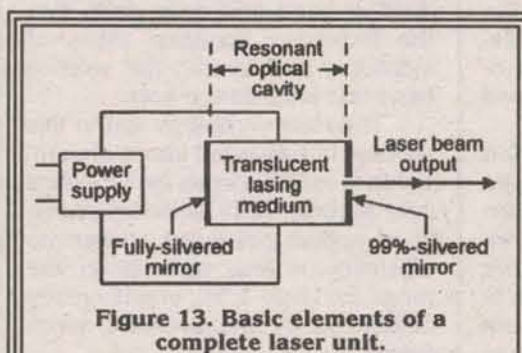


Figure 13. Basic elements of a complete laser unit.

sharply than other types of light.

Figure 10 shows six typical 'random' photon waveforms emitted by a LED, together with their composite light output waveform (equal to the sum of the six photon waveforms), and Figure 11 shows a similar set of coherent waveforms emitted by a laser. Each diagram spans a 10pS (10 picosecond) time interval (1pS = 1 millionth of a μS) and depicts six newly-generated IR photons with wavelengths of 850nm (= a frequency of 353,000MHz) and an amplitude value of '1 light unit.' The typical relative position of each photon is indicated by a small black dot.

LED's light output is very impure and has a fairly wide spectral bandwidth.

By contrast, the six laser-generated photon waveforms shown in Figure 11 are all exactly in-phase, and the composite output waveform thus has a fixed phase relationship and has a constant amplitude of 6 light units. The laser's light output is thus very pure, with a very narrow spectral bandwidth. Typically, a modern 850nm IR LED has a half-power spectral bandwidth (i.e., the bandwidth at which the light power output falls to half of its maximum value) of about 80nm. Modern 850nm laser diodes, on the other hand, have typical half-power spectral bandwidths of 0.5nm to 5nm, and their light outputs are thus far purer than those of LEDs.

## LASER OPERATING PRINCIPLES

The basic *atomic* operating principle of the laser is in some ways similar to that of the LED. In both cases, a photon is generated in an excited atom when an electron in its conduction band loses energy and drops down into the atom's valence band, annihilating a hole and generating a photon in the process. In the LED, this process occurs randomly, when the electron's energy decays below a critical value.

In the laser, however, the process is initiated by photonic stimulation, in which an external photon with an energy value equal to that of the atom's bandgap enters the atom's bandgap and, by a quantum process known as negative absorption, makes the electron lose energy and drop down into the atom's valence band, thereby annihilating a hole and generating an identical photon.

## PRIMECELL

IF YOU NEED NEW BATTERIES FOR YOUR ELECTRONIC EQUIPMENT  
DON'T PITCH EM! - SEND THEM FOR REBUILDING! - SAVE \$\$\$

CUNARD ASSOC. INC., 9343 US RT 220, Bedford, PA 15522

- WE INSTALL NEW NI-CAD OR NI-MH BATTERIES INTO YOUR ORIGINAL CASE.
- WE IMPROVE CAPACITY TO BETTER THAN ORIGINAL.
- WE FIX WHAT CAN'T BE FOUND. (OR AFFORDED)
- WE PROVIDE QUICK SERVICE / EXTENDED LIFE FOR OLDER EQUIPMENT
- WE OFFER FREE QUOTES. / FREE RETURN IF QUOTE IS REFUSED.
- WE PROPERLY DISPOSE OF YOUR OLD CELLS BY RECYCLING.
- WE GIVE YOU A 12 MONTH WARRANTY.
- WE WILL BE HERE WHEN YOU NEED US / EST. 1986
- WE SAVE YOU \$\$\$ MONEY \$\$\$

• NO JOB IS TOO LARGE OR TOO SMALL ..... VOLUME DISCOUNTS AVAILABLE



GENERAL ELECTRIC	UNIDEN	RADIO SHACK
19A704850P(1200mAh) \$ 34.95	APX650 1050 \$ 29.95	HTX Packs \$ 29.95
19A704860P(1800mAh) \$ 39.95	1000 1010 1070 \$ 34.95	New 8.4V pack & chgr
PL19D429763(777)G1/3 \$ 37.95	1100 1200 Series \$ 36.95	1500mAh nimh \$ 34.95
19A705293P 344A4506P \$ 34.95	BP205 650mAh \$ 19.95	
	BP200 1500mAh \$ 24.95	KENWOOD
	SC150 1500mAh \$ 22.95	PB2 / KNB3 \$ 29.95
		PB21/21H \$ 14.95
MAYXON SA-1155 1160 \$ 39.95		PB25/H26 \$ 24.95
TAD 1450 1510 1520 \$ 21.95		
	ICOM	CORDLESS DRILLS
MOTOROLA	BP2 / BP3 / BP22 \$ 18.95	Any brand 7.2V \$ 18.95
P200 HT600 MT1000	BP5 / BP23 / 24 \$ 24.95	Any brand 9.6V \$ 29.95
NTN 4585 4824 5414 \$ 37.95	BP7 / CM7 / BP8 \$ 32.95	Any brand 12.0V \$ 32.95
NTN 5447 5521 5545 \$ 37.95	BP180 / CM79 \$ 34.95	Any brand 14.4V \$ 37.95
NLN 5860 NTN 4327 \$ 39.95		Any Brand 18.0V \$ 45.95
	YAesu	COMPUTER PACKS
MIDLAND	FNB 3 4 12 14 16 \$ 32.95	Send battery for quote.
70-B10 B16 B19 B21 \$ 39.95	FNB19 21 26 27 38 \$ 32.95	
B25 B26 B32 B36 B60 \$ 39.95	FNB 10 1117 25 35 \$ 23.95	

FOR INFORMATION ABOUT YOUR REQUIREMENTS ..... CONTACT US:  
PHONE OR FAX : (814) 623-7000 E-MAIL TO: PRIMECELL @ AOL.COM  
SEND YOUR PACKS FOR FREE QUOTATION VIA UPS, RPS OR US MAIL  
VISIT OUR WEB SITE: <http://members.aol.com/primecell/primecell.htm>

## BATTERY REBUILD SERVICE

MANY OTHERS AVAILABLE - WRITE OR CALL  
**FREE CATALOG**  
ADD \$4.50 SHIPPING & HANDLING PER ORDER

Master Card

VISA

## CABLE TV(MMDS) CONVERTER

Our converters are designed for your specific need

**85 Ch Plain Converter, Ch-3, AFT/MFT**  
PG Lock, HRC/STD and Sleep Timer  
Price: between \$29 - \$49

**99 Ch Plain Converter, Ch-3, AFT/MFT**  
PG Lock, HRC/STD and Sleep Timer  
Price: between \$49 - \$69

**125 Ch Volume Converter, Ch-3/4 out**  
ACW/MFT, PG Lock, HRC/STD and Sleep Timer  
Price: between \$59 - \$89

**FREE BROCHURE**  
**CALL (310)515-5085 or**  
**FAX 1-800-579-5000**

**PCW Company**



Figure 12 illustrates the basic atomic operation of the 'lasing' process. Here, the incident (arriving) photon, which has an energy value identical to that of the atom's conduction-valence bandgap ( $= hf$ ), enters the bandgap from the left side of the diagram and makes the electron drop down and annihilate the hole, thereby generating a new 'laser' photon, which also has an energy value of  $hf$ . The incident and laser photons, which have identical phase and frequency-wavelength values, then emerge together on the right side of the diagram.

Note from the above descriptions that lasing action can only occur if the atom is in an excited state at the moment that the incident photon arrives, and if the incident photon's energy value equals that of the atom's bandgap. Also note that, if lasing action does occur, the excited atom gives an effective 2:1 overall photonic power gain, but drops out of the vital 'excited' state after generating a single photon.

In a practical laser, the actual lasing medium (which contains vast numbers of atoms capable of giving lasing action) may take the form of a gas, a liquid, or a solid material, in which the lasing atoms may be raised into an excited state by electrical, chemical, or optical means.

In laser jargon, the process of feeding energy into the medium to hold its atoms in an excited state is known as *pumping*, and the situation in which most of the medium's atoms are in the excited state is known as a situation of *population inversion*. Thus, the medium must be pumped to create population inversion, which is a prerequisite of laser action. Lasing action can only begin if the medium's energy input exceeds a certain *pumping threshold* value; to give continuous lasing, the medium must be continuously pumped.

Figure 13 shows the basic elements of a complete laser unit. One of these is the actual lasing medium, which must be reasonably translucent. Another is a power supply that is used to pump the medium into a state of population inversion and initiate the lasing action. The final unit is a resonant optical cavity, made of two mirrors set at opposite ends of the lasing medium so that photons can repeatedly bounce back and forth through the medium; one mirror is fully reflective; the other has a small (equal to about 1% of the mirror's surface area) translucent hole in its center.

In Figure 13, lasing begins when — with the medium pumped up to its threshold value — a suitable internally- or externally-generated incident photon hits an excited atom and initiates the birth of an identical photon. This pair of photons then travel to the right, hit the end of the cavity, then reflect back and forth through the cavity, repeat-

edly passing through the lasing medium and initiating the generation of more photons in each pass, so that the photon flow rapidly builds up into a flood that can easily be controlled via the power supply.

Photons that strike the translucent hole at the center of the cavity's right-hand mirror emerge (*bleed off*) from the laser unit in a narrow and coherent beam that can be focused into a minute and intense spot by an external lens.

The optically-resonant cavity is a vital part of the laser system. It is highly wavelength-selective and gives high optical gain (resonance) only to signals with an integer number of half-wavelengths that fit exactly into the cavity's optical length (equal to the product of its physical length and refractive index value).

The cavity's length is inevitably many times longer than the (roughly 1000nm) optical wavelength of the basic laser beam, and it thus has a huge number of optical operating *modes* (wavelengths at which resonance may occur). In a cavity with an optical length of 2mm, for example, the first mode occurs at a wavelength of 4mm, the 10th at 0.4mm, the 100th at 40μm, the 1000th at 4000nm, the 4705th at 850.16nm, the 4706th at 850nm (a commonly-used IR wavelength), and the 4707th at 849.8nm.

The optical cavity's frequency response thus consists of a series of sharp comb-like peaks (known as *mode lines* in laser jargon), as shown in Figure 14(a). In the above example, at wavelengths around

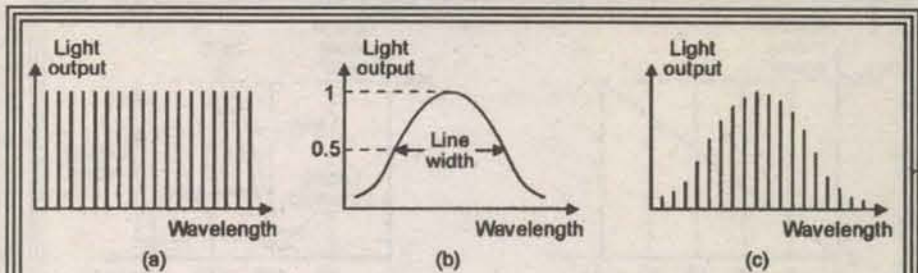


Figure 14. Typical frequency response of (a) a laser's optically-resonant cavity, (b) the unfiltered output of a lasing medium, and (c) the resulting laser-beam output of the cavity.

850nm, these peaks are spaced roughly 0.2nm apart. In some practical lasers (including many laser diodes), the lasing medium's basic (unfiltered) output has the type of frequency response shown in Figure 14(b), and spans dozens of these peaks; in such cases, the cavity's laser-beam output thus has the type of frequency response shown in Figure 14(c).

In laser jargon, the half-power spectral bandwidth of a laser output is called its *linewidth*. Lasers with linewidths that fit into a single mode line are known as *single mode* lasers; ones with linewidths that span more than one mode line (as in the case of Figure 14(c)) are known as *multi mode* lasers.

All practical lasers have finite linewidths and (since they contain a

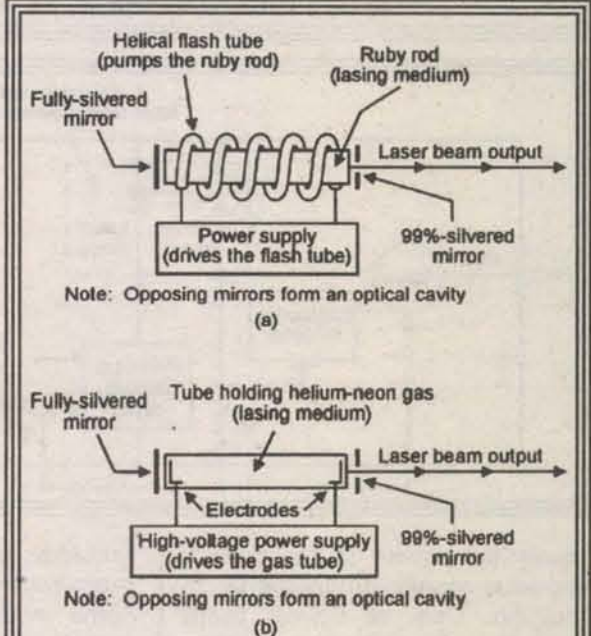


Figure 15. Basic functional diagrams of (a) ruby and (b) helium-neon lasers.

spectrum of frequencies) their beams can remain fully coherent (in-phase) for only a limited number of wavelengths after their initial creation. This dimension is known as the beam's *coherence length*, and

## PRINTED CIRCUIT BOARDS

DELIVERY ON TIME WITH QUALITY

- Prototype through production
- UL approved
- Single and double side
- Multilayers
- SMOBC
- LPI mask
- Through hole or SMT
- Nickel & gold plating
- Scoring and routing
- Electrical testing
- Artwork or CAD data
- Quick quotes

CALL FOR  
SPECIAL  
OFFERS!

### SKY ELECTRONICS, INC.

10235 PACIFIC AVE., FRANKLIN PARK, IL 60131

PHONE: (847) 671-0786 • FAX: (847) 671-0791

MODEM: (847) 671-0770 • E-MAIL: SKY\_EL@yahoo.com

WEB: <http://www.hotyellow98.com/thesky>

## World Passing You By?

Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Fortran Compilers. So don't be left behind; this is information you need to know!

### Examples Include:

- Measuring Temperature
- Using a Photocell to Detect Light Levels
- Making a Waveform Generator
- Constructing a Capacitance Meter
- Motor Speed Control Using Back EMF
- Interfacing and Controlling Stepper Motors
- Scanning Keypads and Writing to LCD/LED Displays
- Bus Interfacing an 8255 PPI
- Using the Primer as an EPROM Programmer
- DTMF Autodialer & Remote Controller (New!)

The PRIMER is only \$119.95 in kit form. The PRIMER Assembled & Tested is \$169.95. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade (\$49.95). The Upgrade includes: an RS232 serial port & cable, 32K of battery backed RAM, & Assembler/Editor software. Please add \$5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad (\$29.95) installed. Satisfaction guaranteed.

**EMAC, inc.**  
11 EMAC WAY, CARBONDALE, IL 62901  
618-529-4525 Fax 457-0110 BBS 529-5708

World Wide Web: <http://www.emacinc.com>

1985 - 1998  
OVER  
12  
YEARS  
OF SERVICE



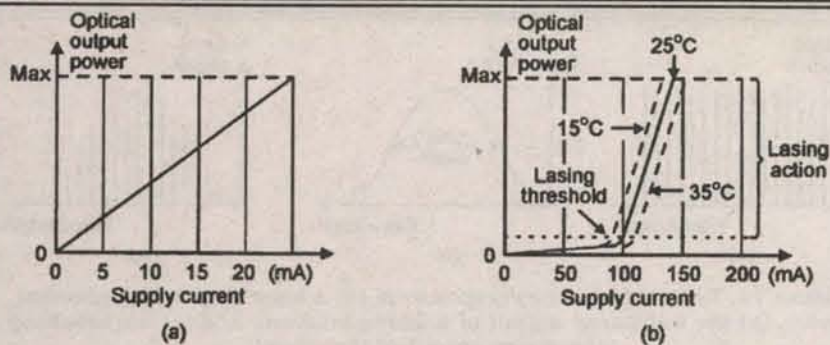


Figure 16. Typical supply-current to optical-output-power graphs of (a) a normal LED and (b) a laser diode.

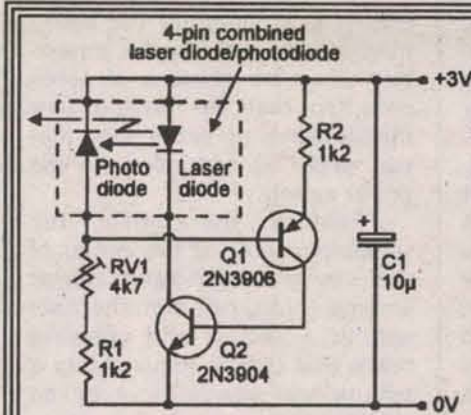


Figure 17. Simple way of using a four-pin combined laser diode/photo-diode unit in a cw laser transmitter.

monitoring photodiode is converted into a DC offset voltage via an integrating amplifier, is combined with an RV1-derived pre-set DC bias voltage via an adder, and is fed to one input of the laser-driving pulsing and biasing circuit, which has its other input driven by external pulse-coded waveforms. The RV1-derived DC bias voltage is set so that — in the absence of input pulses — the laser diode is biased at its lasing threshold value (rather than fully off), thus giving a very fast switching action.

## LASER APPLICATIONS

**WARNING.** Sensible safety precautions must always be taken when using lasers; the output beam of even a 0.5mW type can cause severe optical damage if aimed (deliberately or accidentally) at a human eye.

Low-power (up to 5mW) lasers are readily available in 'module' form, comprising the actual laser plus its drive circuitry and optics. They have a multitude of practical applications. Simple cw types, using the basic type of circuit shown in Figure 17, can — if generating a visible red beam — be used as laser pointers, spirit levels, or alignment aids, or as the basis of bar-code readers. Alternatively, infrared types can be used in a wide range of security applications, activating an alarm or initiating some other action when a person, animal, object, vehicle, smoke, or fog breaks or reflects the beam. When reflected from a solid surface, the cw beam can also be used to detect minute vibrations of the surface.

All CD and CD-ROM players incorporate a small cw laser module that (aided by various lenses and servo-drivers) automatically scans the spinning CD and picks out the information contained in the tracks (which are spaced only 1.6μm apart) of its coded sub-surface data pits, which are each a mere 0.1μm deep and 0.8μm to 3.5μm long, retrieving the data at a rate of over 4,000,000 bits per second.

Laser modules that are designed for use as modulated cw types can be used in all of the types of 'security' applications already mentioned, plus various speed- and distance-measuring applications. They are particularly useful in long-haul fiber optic communication and data-transfer systems, in which (because of their very small spectral bandwidths) they can greatly outperform LEDs.

Single mode IR laser diodes, for example, have spectral linewidths of only 0.5nm, compared to 80nm for LEDs, and their signals thus suffer far less material dispersion than those of LEDs when traveling through long lengths of fiber optic cable. **NV**

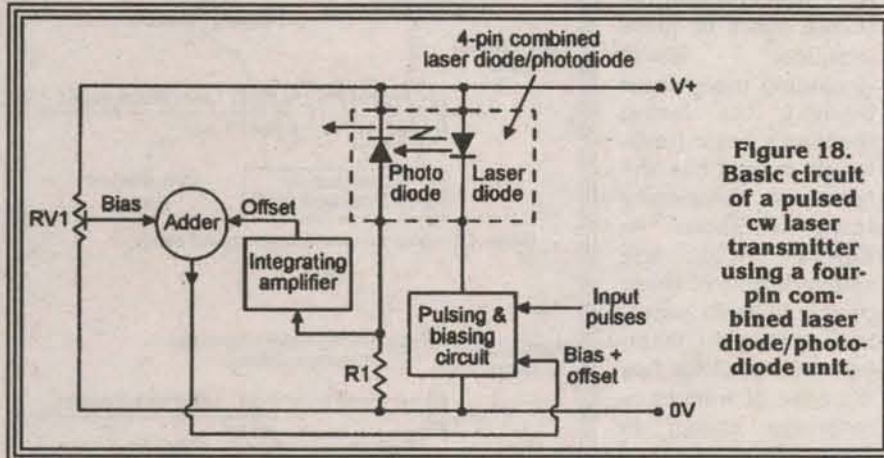


Figure 18. Basic circuit of a pulsed cw laser transmitter using a four-pin combined laser diode/photo-diode unit.

equals the square of the beam's mid-value wavelength divided by its linewidth. Thus, an 850nm beam with a linewidth of 2nm has a coherence length of only 0.36mm.

## LASER TYPES

The world's first working optical laser was demonstrated by an American, Theodore Maiman, in mid-1960. Known as a ruby laser, it has the basic form shown in Figure 15(a) and consists of a small rod of synthetic ruby crystal (the lasing medium), with mirrored ends that form the optical cavity; the rod is surrounded by an electrically powered helical flash tube, which acts as the medium's energy pump. When the flash tube is operated, its white light pumps the rod's atoms into an excited state, and a brief burst of lasing action commences a few milliseconds later, causing a brief pulse of red laser light to emerge from one end of the tube.

The ruby laser provides only brief pulses of laser light. The first laser to give continuous-wave (cw) operation was the helium-neon (He-Ne) gas laser, which was first demonstrated in late 1960 and has the basic form shown in Figure 15(b). Here, the high-voltage supply pumps the gas molecules into an excited conductive state in which sustained lasing action takes place (typical supply voltages are 8kV for starting, 1.5kV when running); lasing takes place primarily at a wavelength of 632nm and the device thus generates a bright red laser beam.

He-Ne lasers are still widely used; most have maximum optical output powers in the range 0.5 to 10mW; the outputs have typical

linewidths of a mere 0.002nm and beam coherence lengths of 200mm. Some modern He-Ne lasers have outputs that can be electronically modulated (but not pulsed) at frequencies up to 1MHz.

Many other types of laser have appeared since 1960. Most have severe practical disadvantages (such as very brief working lives, excessive cost, fragility, or bulkiness, or severe thermal operating requirements) or are meant only for laboratory or military use. Some are designed specifically for use in optical welding or cutting operations, and are not suitable for use in general 'electronic' applications. Most have input-to-output power conversion efficiencies of only 0.001 to 0.5 percent (a 1mW He-Ne laser, for example, typically needs an input power of 20W).

The laser best suited to use in general electronic applications is the so-called 'laser diode,' which (in most low-power types) acts like a laser version of the double hetero-junction side-emitting LED, with a built-in resonant optical cavity. It is compact, robust, has a typical working life of 50,000+ hours, and is reasonably easy to use.

A laser diode produces a cw laser beam that can be pulse or analog modulated at frequencies up to many hundreds of MHz, has a typical input-to-output power conversion efficiency of 1.5%, and is commercially available in versions giving maximum optical power outputs ranging from 0.1mW to several watts, at a variety of red and infrared wavelengths. Single mode types have typical linewidths of less than 0.5nm; multi mode types have typical linewidths in the range 2nm to 5nm.

Figure 16(a) shows the typical supply-current to optical-output-power graph of a normal LED, and Figure 16(b) shows that of a laser diode. The LED's graph is quite linear, and the optical output power is directly proportional to the LED's supply current value. The laser diode has a more complex performance graph; at supply currents well below the lasing threshold value, it acts like a normal LED and generates random photons, but at currents well above the lasing threshold, it gives true lasing action and generates coherent photons. When operating at the actual lasing threshold level, it generates both random and coherent photons.

Note in Figure 16(b) that, at any fixed lasing current values, the optical output power is very sensitive to variations in the laser diode's temperature. Most practical laser diode units (modules) incorporate sensing and control circuitry that stabilizes the optical output power by auto-adjusting the lasing drive current. Most modern units of this type use special laser diodes that have an integral monitoring photodiode; Figure 17 shows a four-pin version of such a unit, together with a simple way of using it as a cw laser transmitter.

In Figure 17, the photodiode's reverse current (and thus the voltage on Q1 base) is proportional to the laser beam's intensity. Q1 acts as a voltage-controlled constant-current generator that supplies base drive to Q2 which, in turn, provides drive current to the laser diode.

The overall action is such that, if the laser intensity falls below a value preset via RV1, the photodiode-derived Q1-base voltage also falls, thereby increasing Q1's current drive to Q2 base and causing Q2 to increase the drive current to the laser diode, which responds by increasing its laser intensity.

The reverse process occurs if the laser intensity rises above the preset value. The circuit thus auto-regulates the laser beam intensity.

Figure 18 shows a basic way of using the four-pin combined laser diode/photo-diode unit in a pulse modulated cw laser transmitter. Here, the pulsed output of the laser-



# We've Got It!

## MCM Electronics®

For over 20 years, MCM has been the leading supplier to the electronics service industry. Huge inventory, rapid delivery and competitive prices have made MCM the choice for:

- Hobbyists
- Service Technicians
- Educators
- Installers

### Chip Quik™ SMD Removal Kit

Provides the items you need to safely remove and replace surface mount devices without the need for costly rework equipment. Includes special removal alloy, desoldering braid and flux. The only additional items needed are a soldering iron and dental pick. Contains enough material for 8-10 SMDs.

Regular price \$17.95

Order #  
#21-3450  
\$13.99

### Solder Station

#### TENMA®

Perfect for most soldering applications including SMD. Overheat protection with closed loop temperature control provides precise heat. Includes replaceable iron clad conical 3/64" tip. Linear LED display shows operating temperature.

Regular price \$79.95

Order #  
#21-147  
\$49.95

### Portable DMM

#### TENMA®

Affordable hand held meter features 3 1/2 digit LCD display, DC voltage measurement to 600V, transistor and battery test. Input impedance 10Mohm. Includes holster and test leads.

Regular price \$31.95

Order #  
#72-2055  
\$24.50

### Prototype Boards

#### Small PC

This prototype board features 25 rows of connections. The center two rows are one connection the length of the board. The outside 2 holes are common connection on both sides of the board and all rows. Each row also features 2 separate holes, 3 separate holes with 2 sets of 3 holes with common connections. Board measures 2 1/8" x 1 1/8" x 1/16".

Order #  
#21-4590  
99¢

#### Medium Size

This board was designed for medium sized circuits with room for several ICs and lots of components. The outside traces are all connected while the center was designed to accept multiple ICs with 45 traces available for multiple connections. Board dimensions are 5 1/4" x 1 1/4" x 1/16".

Order #  
#21-4580  
\$1.29

#### Small IC

Board was designed for ICs to straddle center of board. There are 26 rows designated for IC pin connections with 2 additional connections for IC with added connections toward outer edges of board. Board measures 1 1/8" x 1 1/8" x 1/16".

Order #  
#21-4575  
99¢

### Replacement Automotive Speakers

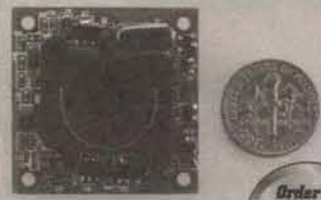
All models feature paper cones with weather resistant foam surround, and a "wizzer" cone for extended high frequency response. Intended for direct replacement, these models include no mounting hardware, grills or speaker wire. Sold individually. **Specifications:** •Power capacity: 10W RMS (#60-9244 15W RMS) •Impedance: 4ohm

Fig.	Order #	Size	Response	SPL	Magnet	Reg.	Sale
A	60-9240	4" round	80Hz~20KHz	78.6dB	4 oz.	\$2.99	\$1.85
B	60-9241	5" round	80Hz~20KHz	84.2 dB	5.3 oz.	2.99	1.85
C	60-9242	6 1/2" round	65Hz~16KHz	82.8 dB	5.3 oz.	3.59	2.29
D	60-9243	4" x 6"	80Hz~16KHz	77.0dB	5.3 oz.	3.59	2.29
E	60-9244	6" x 9"	50Hz~16KHz	84.0dB	8 oz.	5.29	3.59

Prices effective  
May 21, through  
June 30, 1999.

To take advantage of special pricing on  
the items listed, please provide this  
code: **NVM25**

### Micro PC Board Camera

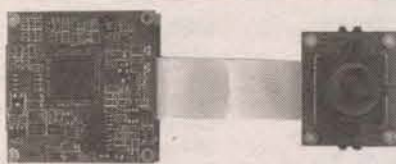


#### DEFENDER SECURITY

B/W CCD camera measures only 1 1/4" x 1 1/4" x 1". Provides NTSC composite video output. Built-in 3.6mm lens provides viewing angle of 92°. Requires 12VDC, 300mA. (#58-3330 AC adaptor). Regular price \$64.95

Order #  
#82-2990  
\$64.95

### Color PC Board Camera



#### DEFENDER SECURITY

Ideal for any observation, multimedia or security application. Provides NTSC composite video output. Features automatic white balance, 330 lines of horizontal resolution and AGC. Requires 12VDC, 240mA. Regular price \$199.00.

Order #  
#82-3015  
\$149.95

### 8" Rubber Surround Polypropylene Woofer

#### MCM AUDIO SELECT™

Popular woofer design is the foundation of many home and auto speaker systems. 70W/100W RMS/peak capacity, frequency response 30Hz~3.5KHz, 8ohm. Other sizes available. Regular price \$13.50



Order #  
#55-1180  
\$9.95

### 30 Piece Security Tool Kit



Kit includes security torx bits, tri-wing bits, security hex bits, Nintendo type bits and more. Ideal when servicing Sega and Nintendo games, PS/2 monitors and more.

Order #  
#22-1376  
\$9.99

### Multi-Voltage Power Supply



Fully regulated supply provides up to two amps, at the following selectable voltages: •3 •4 1/2 •6V •7 1/2V •9V •12V. Regular price 16.95.

Order #  
#28-2200  
\$9.95

### Mylar® Cone Speakers



Clear mylar cone speakers are popular for all weather proof applications. Small round size is also popular as replacements in portable electronics. All models are 8ohm.

Order #	Size	Rated Power	(ea.)
Frequency response 350Hz~7KHz			
SR00186	50mm	1W	\$1.69
Frequency response 350Hz~4.5KHz			
SR00187	66mm	1.5W	1.79
Frequency response 450Hz~4KHz			
SR00188	85mm	6W	2.19

### Dental Type Precision Tool Kit

Stainless steel probe set is and invaluable aid to anyone doing board level soldering repair. Includes straight, curved and angled tip probes.

Regular price \$10.25

Order #  
#21-2305  
\$6.25

### Aluminum Tool/Equipment Case



Includes one tool pallet and pre-cut foam bottom. Ideal for carrying test equipment with small hand tools and accessories. Black finish, measures approximately 19" x 14" x 6". Regular price \$51.50.

#### Clarke

### Same Day Shipping!

In stock orders received by 5:00 p.m. (YOUR TIME), are shipped the same day.

**FREE Catalog**



**MCM ELECTRONICS®**  
650 CONGRESS PARK DR.  
CENTERVILLE, OH 45459  
A PREMIER FARNELL Company

For complete ordering information on the items listed, or a free catalog, Call...

**1-800-543-4330**

www.mcmelectronics.com

SOURCE CODE: NVM25



# DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

## ALABAMA

**Little Professor Book Center**  
2717 S. 18th St.  
Birmingham 35209  
**RT Systems**  
**Amateur Radio Supply**  
8207 Stephanie Dr.  
Huntsville 35802

## ARIZONA

**Batteries Plus #330**  
3014 N. Dobson  
Chandler 85224  
**Batteries Plus #334**  
1155 S. Power Rd. #108  
Mesa 85206  
**Batteries Plus #331**  
2404 E. Bell Rd.  
Phoenix 85032  
**Batteries Plus #332**  
3415 W. Glendale Ave. Ste. 4  
Phoenix 85051  
**Batteries Plus #333**  
1829 E. Southern Ave.  
Tempe 85282  
**Elliott Electronic Supply**  
1251 S. Tyn dall Ave.  
Tucson 85713  
**Tower Records**  
3 E. 9th St.  
Tempe 85281

## AUSTRALIA

**DonTronics**  
P.O. Box 595  
29 Ellesmere Cres.  
Tullamarine 3043  
www.dontronics.com

## CALIFORNIA

**Abletronics**  
9155 Archibald Ave. Unit E  
Cucamonga 91730  
**Advanced Computer Products, Inc.**  
1310 "B" E. Edinger Ave.  
Santa Ana 92705  
**All Electronics**  
905 S. Vermont Ave.  
Los Angeles 90006  
14928 Oxnard St.  
Van Nuys 91411  
**Allen's To Go**  
13461 Hwy. 88  
Lockeford 95237  
**Alltronics**  
2300-D Zanker Rd.  
San Jose 95131  
**Brand Newsstand**  
234-1/2 N. Brand Blvd.  
Glendale 91203  
**Centerfold International**  
716 N. Fairfax Ave.  
Los Angeles 90046  
**Del Amo Books & News**  
3758 Sepulveda Blvd.  
Torrance 90505  
**DSS Satellite Comm.**  
411-E 18th St. #C  
Oakland 94606  
**Electro Mavin**  
2985 E. Harcourt St.  
Rancho Dominguez 90221  
**Ford Electronics**  
8431 Commonwealth Ave.  
Buena Park 90621  
**Harding Way News**  
113 W. Harding Way  
Stockton 95204  
**Harold's Newsstand**  
524 Geary St.  
San Francisco 94102  
**Hi-Fi Doctor**  
1814 E. Ball Rd.  
Anaheim 92805

## HSC Electronic Supply

4837 Amber Ln.  
Sacramento 95841  
3500 Ryder St.  
Santa Clara 95051  
5681 Redwood Dr.  
Rohnert Park 94928  
**Hyaft Electronic Surplus**  
371 N. Johnson Ave.  
El Cajon 92020  
**JK Electronics**  
6395 Westminster Ave.  
Westminster 92683  
**Laurel Park News**  
4346 Laurel Canyon Blvd.  
Studio City 91604  
**Lion Electronic Labs**  
4948 E. Townsend Ave.  
Fresno 93727  
**Netseller**  
7207 Arlington Ave. Ste. G  
Riverside 92503  
**Op Amp Technical Books**  
1033 N. Sycamore Ave.  
Los Angeles 90038  
**Panorama Electronics**  
8737 Van Nuys Blvd.  
Panorama City 91402  
**Sandy's Electronics Supply, Inc.**  
20655 Soledad Cyn. Rd. #15  
Santa Clarita 91351  
**Sav-On Electronics**  
13225 Harbor Blvd.  
Garden Grove 92643  
**SIERRA MADRE NEWSSTAND**  
55 N. Baldwin Ave.  
Sierra Madre 91024  
**The Red Barn**  
Hwy. 299  
Bieber 96009  
**Tower Books**  
211 Main St.  
Chico 95928  
7840 Macy Plaza Dr.  
Citrus Heights 95610  
1280 E. Willow Pass Rd.  
Concord 94520  
630 San Antonio Rd.  
Mountain View 94040  
1600 Broadway  
Sacramento 95818  
5950 Florin Rd.  
Sacramento 95823  
2538 Watt Ave.  
Sacramento 95821

## Tower Records/Video

220 N. Beach Blvd.  
Anaheim 92801  
2520 Durant  
Berkeley 94704  
212 F St.  
Davis 95616  
5703 Christie Ave.  
Emeryville 94608  
2052 Redwood Hwy.  
Greenbrae 94904  
6310 E. Pacific Coast Hwy.  
Long Beach 90803  
2280 Market St.  
San Francisco 94114  
3205 20th Ave.  
San Francisco 94132  
2525 Jones St.  
San Francisco 94133  
871 Blossom Hill Rd.  
San Jose 95123

## Video Electronics

3829 University Ave.  
San Diego 92105

## CANADA

**Com-West Radio Systems Ltd.**  
8206 Ontario St. #100  
Vancouver, BC V5X 3E3  
**Muir Communications Ltd.**  
3214 Douglas St.  
Victoria, BC V8Z 3K6

## COLORADO

**TH Electronics**  
216 Commerce Dr., Unit 2  
Ft. Collins 80524  
**Tower Records/Video**  
2500 E. 1st Ave.  
Denver 80206

## CONNECTICUT

**Archway News**  
64 Bank St.  
New Milford 06776  
**Electronic Service Products**  
437 Washington Ave.  
North Haven 06473

## DELAWARE

**Newark Newsstand**  
70 E. Main St.  
Newark 19711

## DISTRICT OF COLUMBIA

**Tower Records**  
2000 Pennsylvania Ave.  
Washington 20006

## FLORIDA

**Alfa Electronic Supply**  
1502 S. St. Rd. #7  
Hollywood 33023  
**Al's News**  
8219 S.W. 124th St.  
Miami 33156  
**Bob's News & Books**  
1515 S. Andrew Ave.  
Fort Lauderdale 33316  
**Clarks Out of Town News**  
303 S. Andrews Ave.  
Fort Lauderdale 33301  
**Mike's Electronic Distributing Co.**  
1001 N.W. 52nd St.  
Fort Lauderdale 33309  
**Skycraft Parts & Surplus, Inc.**  
2245 W. Fairbanks  
Winter Park 32789  
**Sunny's At Sunset, Inc.**  
8260 Sunset Strip  
Sunrise 33322

## GEORGIA

**Tower Records**  
3400 Around Lenox Dr. N.E.  
Atlanta 30326

## HAWAII

**SolarWorks!**  
525 Lotus Blossom Ln.  
Ocean View 96737  
**Tower Records**  
4211 Wai ala e Ave.  
Honolulu 96816  
611 Keeaumoku  
Honolulu 96814

## IDAHO

**The Current Source**  
5159 Glenwood  
Boise 83714

## ILLINOIS

**Tower Records/Video/Books**  
383 W. Army Trail Rd.

Bloomington 60108  
2301 N. Clark St. #200  
Chicago 60614

1209 E. Golf Rd.  
Schaumburg 60173

## INDIANA

**Harbourtown Sales**  
108 Park 32 W. Dr.  
Noblesville 46060

## KANSAS

**Hollywood At Home**  
9063 Metcalf Ave.  
Overland Park 66212  
**Lloyd's Radio & Electronic, Inc.**  
220 W. Harry St.  
Wichita 67213

## LOUISIANA

**Lakeside News**  
3323 Severn Ave.  
Metairie 70002

## MARYLAND

**Silicon Valley Electronics**  
2014-A Industrial Dr.  
Annapolis 21401  
**Tower Records/Video**  
2566 Solomons Island Rd.  
Annapolis 21401  
1601 Rockville Pike #210  
Rockville 20852

## MASSACHUSETTS

**Newsbreak, Inc.**  
579 G.A.R. Hwy. Rt. 6  
Swansea 02777  
**Tower Records #172**  
360 Newbury St.  
Boston 02115

## MICHIGAN

**Little Professors Book Center**  
22174 Michigan Ave.  
Dearborn 48124  
**Purchase Radio Supply, Inc.**  
327 E. Hoover Ave.  
Ann Arbor 48104  
**Tower Records**  
1214 S. University Ave.  
Ann Arbor 48104

## MINNESOTA

**Radio City, Inc.**  
2633 County Road 1  
Mounds View 55112

## MISSOURI

**Accurate Instruments**  
11201 E. 24 Hwy.  
Independence 64054  
**Electronics Exchange**  
8644 St. Charles Rock Rd.  
St. Louis 63114

## NEVADA

**Amateur Electronic Supply**  
1072 N. Rancho Dr.  
Las Vegas 89106  
**Less Buster's Electronics**  
2930 N. Las Vegas Blvd.  
VSTG-22  
North Las Vegas 89030  
**Radio World**  
1656 Nevada Hwy.  
Boulder City 89005  
**Tower Records/Video**  
4580 W. Sahara Ave.  
Las Vegas 89102

6450 S. Virginia  
Reno 89511

## NEW JERSEY

**JR Tech Systems**  
1309 Hwy. 71  
Belmar 07719

## NEW YORK

**All Phase Video Security, Inc.**  
70 Cain Dr.  
Brentwood 11717  
**Ham Central**  
3 Neptune Rd.  
Poughkeepsie 12601  
**Hirsch Sales Corporation**  
219 California Dr.  
Williamsville 14221  
**Tower Records/Video**  
105 Old Country Rd.  
Carle Place 11514  
350-370 Route 110  
Huntington 11746  
1961 Broadway  
New York 10023  
383 Lafayette St.  
New York 10003

## OHIO

**Compustuff**  
241 Great Oaks Trl.  
Wadsworth 44281  
**Digital One**  
7603 Mentor Ave.  
Mentor 44060  
**Footsteps**  
4925 Jackman Rd. Store #58  
Toledo 43613  
**Hosfelt Electronics, Inc.**  
2700 Sunset Blvd.  
Steubenville 43952  
**Keyways, Inc.**  
204 S. 3rd St.  
Miamisburg 45342  
**Leo's Book Shop**  
330 N. Superior St.  
Toledo 43604  
**Powernax, Inc.**  
1587 U.S. Route 68 N.  
Xenia 45385

## OKLAHOMA

**Steve's Books & Magazines**  
2612 S. Harvard  
Tulsa 74114  
**Taylor News & Books**  
133 W. Main, Ste. 102  
Oklahoma City 73102

## OREGON

**News & Smokes**  
2295 W. Main St.  
Medford 97501  
**News & Smokes #8**  
259-C Barnett Rd.  
Medford 97501  
**Norvac Electronics**  
7940 S.W. Nimbus Ave. Bldg. 8  
Beaverton 97005  
960 Conger  
Eugene 97402  
1545 N. Commercial N.E.  
Salem 97303  
**Powell's Technical Bookstore**  
33 N.W. Park  
Portland 97209  
**Tower Books**  
1307 N.E. 102nd Ave.  
Portland 97220

## PENNSYLVANIA

**Bedford St. News**  
308 Bedford St.  
Johnstown 15901  
**Genes Books, Inc.**  
King of Prussia Plaza  
King of Prussia 19406  
**Lehman Scientific**  
85 Surrey Dr.  
Wrightsville 17368  
**Tower Books**  
425 South St.  
Philadelphia 19147  
**Tower Records**  
340 W. Dekalb Pike  
King of Prussia 19406  
**SOUTH CAROLINA**  
**555 Electronics**  
5646 Farrow Rd.  
Columbia 29203  
**TENNESSEE**  
**Tower Books**  
105 Old Country Rd.  
Nashville 37203  
**TEXAS**  
**BDL News, Inc.**  
809 Pierce  
Houston 77002  
**Electronic Parts Outlet**  
3753-B Fondren Rd.  
Houston 77063  
**Mouser Electronics**  
958 N. Main St.  
Mansfield 76063  
**Tanner Electronics**  
1301 W. Beltline #105  
Carrollton 75006  
**Tower Records**  
2403 Guadalupe St.  
Austin 78705  
**VIRGINIA**  
**American Computer Clearance**  
1609 Rhoadmiller St.  
Richmond 23220  
**Tower Records/Video/Books**  
4110 W. Ox Rd. #12124  
Fairfax 22033  
1601 Willow Lawn Dr.  
Richmond 23230  
8389 E. Leesburg Pike  
Vienna 22182  
**WASHINGTON**  
**A-B-C Communications, Inc.**  
17541 15th Ave. N.E.  
Seattle 98155  
**Bohica Concepts**  
214 2nd St.  
Morton 98356  
**Cody Books Ltd.**  
1125 Fir Ave.  
Blaine 98230  
**Service Request**  
3304 W. Rowan Ave.  
Spokane 99205  
**Supertronix**  
16550 W. Valley Hwy.  
Seattle 98188  
**Tower Books**  
10635 N.E. 8th St.  
Bellevue 98004  
20 Mercer St.  
Seattle 98109  
**WISCONSIN**  
**Amateur Electronic Supply, Inc.**  
5710 W. Good Hope Rd.  
Milwaukee 53223  
**Greenfield News & Hobby**  
6815 W. Layton Ave.  
Greenfield 53220  
**Cuddey News & Hobby Ctr.**  
4758 Packard Ave.  
Cudahy 53110  
**WYOMING**  
**Western Test Systems**  
2701 Westland Ct. #B  
Cheyenne 82001



### PRECISE, KENSINGTON LABS, XY STAGE.

Model 8500-6X, 6"x6" of high performance travel. One of the best linear stages available. Highly repeatable, ultra-precise. Precision ground surfaces result in unmatched laboratory-grade performance. Linear glass scale, internally attached to the table, eliminates all drivetrain errors not measurable when an encoder is attached to the motor. System provides up to 0.025µm res. over 100 mm. Built from stress relieved 7075 aluminum. Crossed-roller bearings for excellent stiffness, load capacity and lifetime. Combined with a very low friction preloaded leadscrew and DC servo motor drive provides 20,000 hour MTBF. 100 mm/sec maximum speed and >50kg load capacity. Size: 15"L x 9"W x 2.75"H. Regular price > \$4K. X&Y stage with motors no drivers. USED, Very good condition. **8500-6, XY LINEAR STAGE .....\$1795**



### BAYSIDE, RIGHT ANGLE, GEARHEAD DRIVE

#### PERFORMANCE SPECS:

Gearhead	Torque	Peak Torque	Input Speed	Backlash	Eff.
Model	in-lb (Nm)	in-lb (Nm)	RPM	arcmin	%
NR 23	50 (6)	100 (11)	4,000	30	92
Moment of Inertia	Max. Weight	Radial Load	Axial Load		
kg-m <sup>2</sup> (oz-in-sec <sup>2</sup> )	lb (kg)	lb (N)	lb (N)		
8x10-5 (6x10-7)	3 (1.4)	150 (670)	100 (440)		

SPECIAL.....\$89ea. or 2 for \$169

### ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAMERA

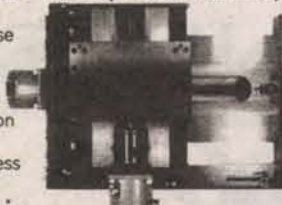
Sleek black anodized, alum. housing. O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mm d X 50mm, 36" cable with BNC video & DC barrel jack. **GM-200K-STD.....\$99**

PINHOLE Model. So tiny you can install it directly into a door. Only a 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2 ounce! Size only 23mm d x 35mm long. Think of the places you could put this little jewel. **GM-200K-PH lens.....\$99**



### DOVER AIR BEARING X/Y TABLES, ULTRA PRECISE,

Like New, The ultimate in precision motion control. These are leadscrew operated air bearing tables with 1-20 Microns typical repeatability. Straightness, less than 1 micron each axis, angular error, less than 1 arc/sec. Squareness, less than 5 arc/sec. Three models available. Model "A" has 6"x6" travel with 2 type 23BL5-021-02, 4.85A 24V Rapidsyn stepper/encoders. Type "B" is as above without motors. Type "C" has 4"x5" travel with two Compumotor LE57-51-MTR steppers. No controllers. **TYPE "A".....\$1200, TYPE "B".....\$949, TYPE "C".....\$849**



### TINY, PRECISE, PORTESCAP, SWISS, GEARMOTOR

State of the art "ironless" type, mini motor. Model B: M11-210-54-0 with approx. 40:1 spur gearbox. Size: 16mm d. x 43mm L with 2mm diam. x 6mm L, flatted shaft, solder terminals. VIN INL RPM B: 6V 8mA 141 12V 12mA 290



**LIMITED QUANTITY TYPE B: \$15ea. or 2 for \$27**

### NEW, LASER DIODE MODULES

SPECIFICATIONS: DC Power: 4.5 - 9V, @65mA Power out: 4.5mw max. Range: 400-800 Meters Glass Collimator Size: 0.41" diam x 0.71" Shown Actual Size



The best value for commercial, Subminiature, laser modules. Glass collimating lens provides 1.5mRad performance. (Divergence comparable to HeNe lasers.) Wide input, internal surface mount, 4.5 to 9VDC power supply. Excellent thermal characteristics. Machined brass.

**650nm 5X Brighter...\$29, 635nm 10X Brighter...\$69, \*635F with adjustable focus...\$89**

**TEK 475, 200 MHz portable, Dual trace, Delayed sweep.....\$649ea.**

**ALL PORTABLE SCOPES INCLUDE PROBE, MANUAL and COVER. TEST EQUIPMENT RECONDITIONED & CALIBRATED, 6 MONTH WARRANTY**

### ARMY TELEPHONE SET, TA-1/PT

#### For Secure Y2K Communications

Like new, direct from depot storage in original boxes. The portable & lightweight handset phone is sound powered, has a built in push to talk ring generator, buzzer volume, and visual indicator for silent call signal. NO BATTERIES or EXTERNAL POWER REQUIRED. Any two conductor wire is all that is needed for interconnection and communication between two phones. Voice transmission range is up to 4 Miles. Freq. Response: 300 Hz to 4000Hz. Operating temp. -40 to +131F. Complete with hard field case and complete manual. An excellent collectors item. **Special.....\$49ea. or 2 for \$89**



### TEKTRONIX 335, MINI SCOPE,

#### Can be AC or DC Powered.

The 35MHz bandwidth and 1mw/Division vertical sensitivity combine to make this compact dual trace scope a true field service performer. Size: 13.6"x9.3" W x 4.4"H Weight: 10.5 lbs. Can be operated from 90

to 264VAC, 48 to 440Hz or 11 to 28VDC. External jack for DC input. Package includes probe, manual, calibration and 6 month warranty. **New...\$3K Now...\$549**

### FAIRLY LARGE CAPs, New, SPRAGUE, 36DX Series

Three values, Aluminum electrolytic, available. All include mounting clamp:

**Type A, 3500uf @ 450VDC \$20ea. 2 for \$39**

**Type B, 1400uf @ 450VDC \$18ea. 2 for \$39**

**Type C, 7400uf @ 200VDC \$15ea. 2 for \$29**

**Concord Elect., Type D, 2500uf @ 450VDC \$15ea. 2 for \$29**

### END FIELD OF VIEW GUESSWORK!

#### 3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97° FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris. **SPECIAL.....\$99ea. or 2 for \$189**



**MINI, LINEAR MOTORIZED MOUNT,** This high quality mini slide provides 2.4" of travel for 1/8" x 1" alum. plate riding on two 0.18" diam steel rods. Motion is via a toothed belt drive from a 1.8" per step, 8 ohm stepper motor. 1 full step - about 0.008" of travel. Overall size: 6"L x 3.5"W x 2.5"H. Dual optical end of travel sensors. Alum. construction. **SPECIAL.....\$24ea. or 5/\$99**



### NEW, KEITHLEY/ACCULEX, DP-2000, 4 1/2 DIGIT,

#### LCD, Digital Panel Meter

Industrial quality 5VDC powered, 19,999 count DPM with 1/2" digits. Requires only 15mW and only 0.73" space behind panel. Perfect for any application requiring precision and portability. User selectable range control provides +/-200mVDC and +/-2VDC option. Auto polarity, overrange, selectable decimal point and display hold functions. Full differential inputs. 100M Ohm input imped. on 200mV range. 1M ohm on 2V range. Snap in mounting. Stability 100ppm/deg C. Regular price.....\$99ea. **SPECIAL.....\$39.00ea. 2 for \$69**

### MAXON, Rare Earth Magnet, PRECISION DC GERMOTOR, 35:1, 2- stage, Planetary gearbox.



Maxon P/N: RE035-071-34EAC200A. All metal construction with mounting ears. Approximately 100RPM at the gearbox output and 4000RPM at the direct output. (Dual shaft design) Direct shaft is 3.9mm diam. X 18mm long. Geared. Shaft size: 6mm diam. x 18mm long. Overall size: 35mm O.D. x 109L not including shafts. Ball bearing outputs. Torque 2.25Nm continuous. Nominal operating voltage: 24VDC @ 40W. No load current 45.7mA, Max. Cont Current: 1.5A. A fantastic motor and always a sellout! **Maxon, Special.....\$39ea.**

## IS ANYBODY OUT THERE?

# RESOURCES UN-LTD.

VISA, MC, AMEX, DISCOVER, COD.

ORDER: 800-810-4070 TECH: 603-668-2499

FAX: 603-644-7825 E-MAIL unltd4u@m20.net

300 BEDFORD STREET, MANCHESTER, NH 03101

### NEW! DAYLIGHT to LOW LIGHT MINI CAM, w A/I LENS

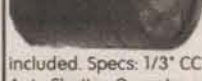
For those applications that must work from dawn 'till dusk, this is it. Rugged aluminum housing with dual mounting sockets. Specs: 1/3" CCD, 420 lines resolution, 0.1 Lux sens., AGC, Auto shutter. 12VDC @120mA. Take full advantage of camera sensitivity with the super, 4mm, f1.4, 78° FOV Auto iris lens included. Video out on BNC. Size: 50mm sq. X 65mm long. Power adapter included. Ready to go! **GM-510-A/I.....\$199ea. or 2 for \$369**

**HIGH RESOLUTION OPTICAL ENCODERS** 2500ppr, 10,000ppr Quadrature! DRC MODEL 25-S351-B17-2500, amp. shaper output. Size: 2.5"d, 1/4" ball bearing with shaft seal. Continuous rotation., 3000 RPM max. Alum. housing, 5V powered with zero reference out, 18" cable. **USED.....\$39ea.**

### CHECK THIS! ULTRA MINI, WEATHERPROOF & COLOR!

**NEW "COLOR LIPSTICK" camera.** For those applications that must be color, this is it. Black anodized, aluminum, housing is O-Ring sealed & RAINPROOF. Adjustable tilting mount included. Specs: 1/3" CCD, 400 Lines resolution, <1 Lux sensitivity, AGC, Auto Shutter, 12VDC @180mA, 4.3mm, 78° FOV lens, A real glass lens. Std. video out. Size: 32mm diam. X 65mm long. 24" leads with RCA jack and DC jack. With pwr. adapter. Ready to go! **SPECIAL this MONTH, GM-400K.....\$219ea.**

**NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN' GO UNDERWATER (down to 60 ft. Waterproof B&W CAMERA with INTERNAL, INFRA-RED ILLUMINATOR!** Sleek black anodized, BRASS, housing is O-Ring sealed & WATERPROOF. Adjustable mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25" diam. X 2" long. With 60 ft. cable. Great for general outdoor use also. **SPECIAL, GM-300KIR.....\$199ea.**



### Brand New, Video Motion Sensor. Model VM10. Attach

to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Use it to turn on a VCR or call the hounds. Auto or manual reset. Compact, ac powered. Adjustable sensitivity. Video loop through jack. **NEW VM-10.....\$189.**

### low-cost MICRO CAMERA, w/audio

1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250k PIXELS, Std. model, 4mm, 78° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size Std: 1.25"sq. x 1"d. PH is 0.6"d, 1.6M long wiring harness with connectors included. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS. Six different models.

**GM-1000A-STD.....\$60 GM-1000A-STD/Aud.....\$65**  
**GM-1000A-PH.....\$60 GM-1000A-PH/Aud.....\$65**  
**GM-1000A-CMNT.....\$60 GM-1000A-CMNT/Aud.....\$65**

**Micro Lenses for GM1000 series**  
2.5mm, 150°.....\$22 8.0mm, f2.0.....\$22  
4.3mm, 78° f1.8.....\$22 12.0mm, f2.0.....\$22  
6.0mm, f2.0.....\$22 5mm, 70°PH.....\$22

**C-MOUNT LENSES**  
**LOW LIGHT** 16mm, f1.6, 15° FOV.....\$39 4mm, 80° FOV.....\$24  
8mm, f1.3, 40° FOV.....\$49 8mm, 40° FOV.....\$24  
4mm, f1.4, 78° FOV.....\$49 12mm, 28° FOV.....\$24

**6V@12AH SEALED, RECHARGEABLE, BATTERY** New Panasonic, LCR6V12PI. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D **2 for \$20, or 10 for \$89**



### NEW, "STEALTH CAM", MICRO, with AUDIO!

The sleek aluminum housing fits like a glove! Removeable mounting bracket and a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC barrel jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM", 1/3" CCD, 410 Lines, 0.3 Lux, AGC, Auto Shutter. Pwr. from 9 to 12VDC @110mA, 250k pixels, Std. model, 4mm, 78° FOV lens, Pinhole model, 90° FOV. A real glass lens. Focus from 10mm to infinity. NTSC video out. Only 1.7 ounce! SENSITIVE to IR. Size Std: 30mm sq. x 29mm d. PH is 16mm d. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS. **GM-2000S-STD, w/aud. ....\$79.00**  
**GM-2000S-PH, w/aud. ....\$79.00**



### 4 HEAD TIME LAPSE VCR, Records 24 HOURS!



Used, refurbished, late model VICON model 424's at only 2/3 off the regular price. On screen programming, time/date stamp, audio, index search, power loss recovery and alarm inputs. Excellent, with manual. **VICON 424, Special.....\$399ea.**

### NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER with SONY, CCM-PC5 COLOR CAMERA.

Originally sold for \$500! Now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic, providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens. (1" to infinity, macro capable) Auto power off when the privacy shutter is closed. Power is 7-13VDC. (all pwr. adapters and cables included) 1/3" CCD, 330lines res. 35% better than standard VHS! Can also be used to transmit VCR output to another TV for remote viewing.

**SPECIAL, 2.4GHz SONY-ASTROVIEW.....\$189ea. or 2 for \$339**  
**addtl. 2.4GHz TRANSMITTER/RCVR. less Camera...\$129ea.**

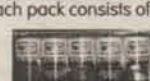
### MOTORIZED ZOOM LENS SPECIAL, 6X mag. and auto iris!

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from \$600 to \$1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. The Auto Iris has a built in amp which works with any cameras video output for control.

**Type B-6, 12.5 to 75mm, 6X, f1.2 ..... \$179 or 2 for \$349**  
**ZOOM LENS CONTROLLER, NEW ..... \$169**

### 10V @ 2.5 AH SEALED, LEAD ACID, PACK

Each pack consists of five, 2 Volt cells. Each cell the size of a std. 'D' battery. They are arranged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Mint condition. Perfect for robotics and other high drain applications. Buy several, make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D **5-five packs for \$20, 30 for \$99**





# ELECTRONICS Q & A

With TJ Byers

*In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, as well as comments and suggestions.*

*You can reach me at:*

**TJBYERS@aol.com**

**TJBYERS@juno.com**

*or by snail mail at  
Nuts & Volts Magazine,  
430 Princeland Ct.,  
Corona, CA 91719.*

## What's Up:

- Our continuing look at switching power supplies: two flyback converters this time and an efficient benchtop power supply.
- Tips on the Variac, and
- relays galore, including a
- driveway announcer and
- semiconductor-less timers/latches. Plus the usual search for unusual items, like a • NASA appliance controller and a
- cordless modem for notebooks, and more.

## Robot On The Run

**Q** - I'm looking for a low-cost RF transceiver for use in a mobile robot project. The transceiver must be able to handle video, audio, and digital data. In addition, it should have a range of 1000' or more. Can you suggest products that might fit the bill?

**K.A. Delahoussaye  
via Internet**

**A** - What you're looking for is commonly used in wireless security systems, where both video and sound are transmitted from one or more remote sites to a central control area. They usually operate in the 2.4 GHz range, and typically have a range of 1000'. Because you want to put this into a robot, I suggest a board version of this setup. It'll save you weight and money over a cabinet version. You can buy 2.4 GHz wireless transmitter and receiver boards from **Matco, Inc.** (800-440-0299; <http://www/matco.com>), model number ASK2000TR (page 73). They boast four-channel auto-scan video and two audio inputs which may be used for digital data. The cost is \$129 for the pair.

## Cordless Modem

**Q** - Do you know of a nifty way to hook-up a laptop computer to a cordless phone so that it could be used "no strings attached" while outdoors?

**Andy Gerkman  
via Internet**

**A** - Yep, a very nifty solution from Panasonic called the KX-TCL100 Data Link. Basically, it's a 900-MHz link between your notebook PC and any RS-111 phone jack, in other words, a cordless phone all by itself. The Data Link consists of two pieces. Simply plug the rechargeable, battery-operated portable (sending) unit into your computer's modem RJ-11 port, then plug in the base receiver into a landline phone jack ... and you're home free. When fully charged, the Data Link battery provides 2.5 days of stand-by service (it receives, too) and up to 2.5 hours of on-line time. The rub is that it sells for about \$200, depending on where you shop (I've seen it as low as \$169). Actually, there's nothing to stop you from plugging your cordless handset into the laptop and doing the same thing. The problem is finding the wires that equal the red and green connections of the base receiver. Here I can't help, because each wireless handset is different. However, if you can locate the handset microphone wires, I believe you can interface those wires to your modem's output connector (red/green wires) with a 1:1 telephone interface transformer. Of course, you'll have to obtain the dial tone manually by pressing the Talk button before beginning transmission. Like I said, I think this will work, but don't quote me. I'd try it myself, but my girlfriend won't let me saw the handset in half to test my theory. Jeeze, and after all the things I do for her.

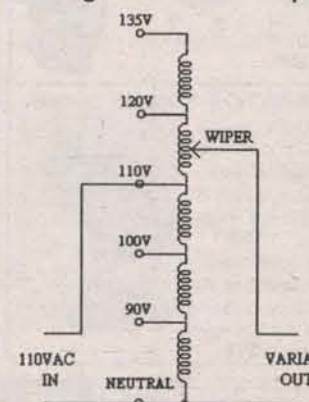
## Variac Basics

**Q** - I recently acquired a General Radio model VBT-10 Variac. It is 5" in diameter by 2-3/4"

high and weighs a "ton." I'd like to enclose it in some type of housing with a meter to indicate the output voltage and need your opinion on this project. There is a diagram on the unit showing a winding in a 270° circle with connections at both ends of the winding and four taps in between. Of course, there's also a connection for the wiper. I wired one of these about 20 years ago, but have since forgot how I did it. Do you know how? (P.S. Do you know what happened to General Radio?)

**Roy E. Kneale  
via Internet**

**A** - The Variac is what's called an autotransformer, that is, it has only a primary, not a secondary, winding. The AC line connects to the bottom of the winding and one of the taps, as shown.



Which tap depends on your line input voltage. The Variac output voltage is a ratio of the input voltage. In the drawing above, the output voltage will be 115VAC. Moving the wiper up increases the output voltage and moving the wiper down decreases it. Your Variac has a rating of 10 amps — about 135 watts. Just remember that the output isn't isolated from the AC line, and you must treat it accordingly.

Now for some history. In 1915, Melville Eastham and four investors founded the General Radio Company in Cambridge, MA to manufacture radio measuring instruments and parts. During WWI, the company expanded its manufacturing capacity to meet the needs of the war effort. One of their products — a precision variable condenser — was used by Major Edwin H. Armstrong to tune his first superheterodyne receiver. After the war, GR intensified its focus on the development of precision measuring instruments, including the first commercially available oscilloscope and the Variac — both of which found major uses in WWII. In the 1950s, GR built a new manufacturing plant in West Concord, MA, and closed the Cambridge facility. The company later moved to Lexington, MA, where they remain today as GenRad Corporation.

## Sensitive Magnetometer

**Q** - Attached is an interesting circuit that appears to sense changes in magnetic fields with a high degree of sensitivity. Any thoughts about where one would locate the mu-metal rod that is the key element of the circuit? The circuit is about 30 years old.

**David LaBorde  
Fort Walton Beach, FL**

**A** - I have both good news and bad news for you. Good news: Mu-metal, also known as Permalloy, is readily available. A nickel-iron alloy (77% nickel, 15% iron, with traces of copper, magnesium, and molybdenum), mu-metal has extremely high magnetic permeability at very low field strengths (i.e., the earth's magnetic field). Because of this property, it's often used as a magnetic shield for sensitive instruments like superconductor sensors and can be found to some extent in many CRT monitors. Bad news: the piece of mu-metal you need for this project is about the size of a toothpick — about 2-1/4" long by .004" thick. Trying to buy this tiny bit of wire from a vendor or jobber isn't easy because they sell the stuff by the pound. Here are three contacts that may be willing to give you a piece if you ask nicely, but don't hold your breath.

**Eagle Alloys Corp.**

1-800-237-9012

<http://www.eaglealloys.com/index.shtml>



**Reade Advanced Materials**

East Coast: 401-433-7000 West Coast: 775-352-1000  
<http://www.reade.com/Products/Categories/alloys.html>

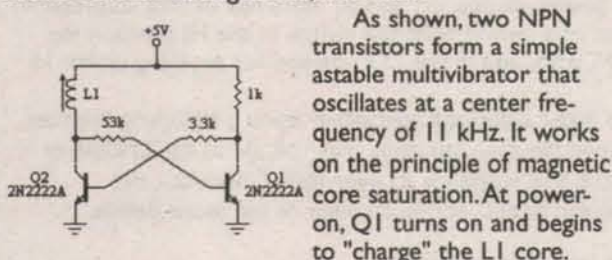
**Magnetic Shield Corporation**

1-888-766-7800

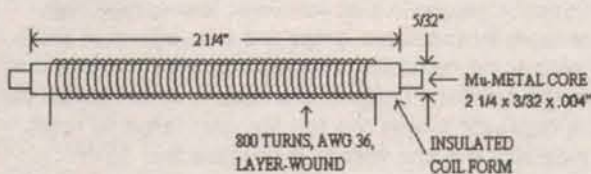
<http://magnetic-shield.com/index.html>

But like I said, mu-metal is plentiful, especially in monitors and oscilloscopes. So what I suggest is canvassing your local TV repair shops and see if one of them has an old monitor or scope destined for the dumpster, and ask if you can salvage the mu-metal shield first. What you'll need to do now is find a seam or edge that's readily available and, using metal shears or hacksaw, cut it to the length you need. The actual size isn't that critical, though, and you may want to experiment with different pieces for best performance. What is important is the coil itself, which has to be wound on a phenolic or plastic tube 3/16-inches in diameter and 2 1/4-inch in length.

Now for those readers who are dying to see the circuit David is talking about, here it is.



When the core saturates, Q1 turns off and Q2 turns on. The magnetic field now collapses, turning Q2 off and Q1 on, causing the cycle to repeat itself. The oscillation frequency is determined by the saturation point of L1's core. As it turns out, mu-metal is a very easily saturated material that's susceptible to external magnetic influence. When a magnet is brought near the mu-metal, the saturation point changes, depending on the magnet's polarity. In one direction the saturation point is reduced, and the output frequency is lowered. In the other direction, the saturation point is strengthened and the output frequency increases. To demonstrate the sensitivity of this design, let me say that the force of the earth's magnetic field will change the frequency from 8 kHz to 14 kHz by simply rotating the coil horizontally from N-S to W-E. Here are the details of the coil.

**Makita, Alive And Well**

Q. As a long-time subscriber of *Nuts & Volts*, I'm sending you a plea for help. I need to replace a burned-out transformer that's part of my "Workshop" 7.2-volt Makita battery charger (Model 07303). It was made in Taiwan and distributed by Atlas Group Co., Fairfield, CT. I cannot find any listing for this company. I also can't cross-reference the case markings stamped on the case. Does such a beast really exist? Any help in identifying the voltage output and how to breakdown the cryptic markings on the charger would be very much appreciated. My belief is that they are dead and long gone.

George K. Coyne  
 via Internet

A. Nope, Makita is quite alive and well (I have some of their tools). They can be reached at 800-462-5482; <http://www.makita.com/>, and have a repair shop in San Jose, CA. Moreover, I called the San

Jose number and got a real live person who knew what I was talking about — Brownie points for Makita! While your particular model is no longer listed among the living, they'll be happy to sell you an upgraded version of the same.

**NASA Chills Out**

Q. This is in response to a reader who, a few months ago, asked about a circuit that reduces the amount of power consumed by appliances like a refrigerator or freezer. I'm sorry, my hard disk ate your name and address, but I hope you'll know who you are when you read the following answer.

Name lost  
 mia culpa

A. The device you're looking for is a NASA invention that was designed to minimize the amount of energy used aboard the Space Shuttle for refrigeration and other cooling devices — way before the Shuttle was but a gleam in its daddy's eye. Basically, it's a power-factor controller that controls the phase angle of the voltage and current supplied to an AC motor for maximum efficiency. I've heard of savings up to 20%, but don't quote me because it depends on the age of your appliance. Bottom line is that you can now check it out for yourself at a very low \$3.98 from **Electronic Goldmine** (800-445-0697; <http://www.goldmine-elec.com>), page 56. The part number is G9946, and it works best with appliances made before 1992.

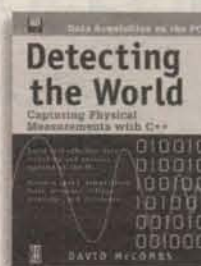
**Benchtop Power Supply Improved**

Q. I've constructed a variable-voltage DC power supply using an LM350 and a 24-volt, 2.5-amp power transformer. The LM350 is attached to a finned heatsink which is additionally cooled with a small CPU fan. One day, I hooked the power supply to a Variac (a continuously variable AC transformer) and reduced the line voltage from 110 down to 80 volts, and discovered that the power transformer and LM350 ran much cooler — even at full load. I have since tried to duplicate this using voltage dropping resistors, but unsuccessfully. Is there any way to reduce the input voltage without having to haul this monstrous Variac around? Perhaps putting a 60W bulb in series with the AC line?

Pete Haas  
 Kent, OH

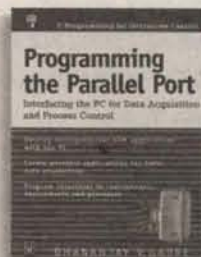
A. What you're experiencing is what engineers call "power dissipation." Simply put, it's a way of converting unwanted electricity into heat — the way an electric stove does. Let's say that the input voltage to the LM350 is 33.6 volts (1.4 x 24V for full-wave rectification) and the output voltage is 24 volts, then the voltage drop across the LM350 is about 10 volts. If the load draws 1 amp, the LM350 has to dissipate 10 watts of power ( $P = EI = 10 \times 1 = 10$  watts). Now let's reduce the output voltage to 5 volts, which means the voltage drop across the LM350 is now 29 volts. If the load draws 1 amp, the regulator must dissipate 29 watts of heat — three times more than before.

What you inadvertently discovered is that by reducing the input voltage, the chip runs cooler. Let's see why. By reducing the input to 80 volts, you've lowered the input voltage to the LM350 from 33.6 volts to 24 volts. This decreases the voltage drop across the LM350 from 29 volts to 19 volts when powering a 5-volt load at 1 amp. That's a 33% reduction in heat generated! Moreover, the efficiency of the power supply is now improved because less power is wasted as heat. Need proof? Just comparing watts in to watts out, for a 110-volt input the total power drawn from the AC line at 5 volts, 1 amp (5 watts) to the load is 33.6 watts (1 amp x 33.6 volts), for an overall efficiency (no other losses) of 15%. Compare that to an efficiency of 21% (1 amp x 24 volts = 24 watts) for an 80-volt input.

[www.rdbooks.com](http://www.rdbooks.com)


by D. McCOMBS

Capture and analyze speed, temperature, force, pressure, voltage, amperage, and resistance with cost-effective PC-based systems. Includes C++ Code operable under Windows 95 or DOS.  
 360pp, disk included  
 ISBN 0-87930-559-2 | \$44.95



by D. V. GADRE

Key topics include: the Enhanced Parallel Port, Extended Communications Port, Analog/Digital Converters, adding bits, hosting an EPROM emulator, connecting to an external microprocessor, and digital waveforms.  
 316pp, disk included  
 ISBN 0-87930-513-4 | \$44.95



CALL 800-500-6875 | FAX 408-848-5784

**R&D BOOKS****MINI-PC \$27**

OEM (1k) PRICE, EVAL (1) \$95  
 INCLUDES:  
 - 3 SERIAL/2 PARALLEL (2264)  
 - UP TO 4MEG ROM (27C440)  
 - BUILT-IN RAM & EPROM  
 - MEM EXPANDABLE TO 640K  
 - REAL TIME CLK/INTERRUPT  
 - LCD AND KEYBOARD PORTS  
 - ON-BOARD LED DISPLAY  
 - STANDARD PC ISA BUS

Perfect when a full-size PC is too large, expensive, or power hungry. A fully functional single board computer, needs only program and power source. Runs DOS. Use Turbo C, BASIC, MASM. All utilities to do this included. 386 versions available starting at \$55. Learn embedded technology!

**UNIVERSAL PROGRAMMER**

**\$95**  
 SINGLE  
 PIECE  
 PRICE  
 EEPROM, UVEPROM, FLASH,  
 NVRAM, DOES UP TO 8 MEG  
 (27080). ADAPTERS FOR  
 MICROS, PLCC, OTHERS,  
 PARALLEL PORT VERSION.

**SINGLE CHIP COMPUTER \$1.99**

**BUILT-IN BASIC!!!**  
 20MIPS-16BIT-10X FASTER THAN 16C54  
 2K FLASH-64EE-REPROGRAMMABLE  
 ZERO EXTERNAL COMPONENTS  
 32MATH REGS-ANALOG COMPARATOR  
 15 I/O 6 SERIAL/3 PARALLEL (ANALOG)  
 RS232C DOWN/LOAD-NO DEVKIT NEEDED  
 3 IRQ-RTC-2.7V TO 7VOLT OPERATION



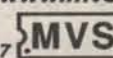
**\$21 PC SOLID STATE DISK**  
 OEM (1k) EVAL 75.00  
 FLASH/16M/EPROM  
 .25-16M/PCMCIA/DIPS

**NO MORE HANGUPS... PC WATCHDOG!**  
 REBOOTS PC 1K \$21 1.95

**VGA LCD** 640x480 CARD FOR SBC OR PC 1K \$27 1.95

web site: [www.mvsweb.com](http://www.mvsweb.com)

MVS BOX 650  
 MERR, NH 03054  
 (508)792-9507



5y limited warranty  
 Free Shipping  
 Hrs: Mon-Fri 10-6



# SUPERCIRCUITS

America's #1 Microvideo Source

AMAZING!

## MICRO VIDEO TOP 10

OVER 120 NEW VIDEO PRODUCTS!

1. World's Smallest Video Camera\* ..... 1 lux, 3oz \$59.95
2. Pinhole Video Camera..... 410 lines, 0.5 lux, Sharp chip \$39.95
3. Color Video Camera ..... 350 lines, 2 lux, Remote head \$69.95
4. Live Aerial Video R/C Videotape..... How to & more \$24.95
5. Wireless Covert Tape Cam ..... 300' range, FCC OK \$349.95
6. Super Tiny Color Pinhole.... 350 lines, less than 1" sq. \$99.95
7. Micro Video Transmitter ..... 1000' range, ATV band \$159.95
8. Complete Wireless ATV Video Set ... 3 Miles Range \$419.95
9. World's Smallest Wireless Video Cam ..... Please Call
10. Video Goggles ..... Dual hi-res LCD's, 30 capable \$599.95



Buy your microvideo equipment where NASA, The Air Force, JPL, Lawrence Livermore Labs and the FBI does. Call us today.

For the best in high performance microvideo equipment, call the experts at Supercircuits. We've grown to be America's microvideo leader by consistently offering the best equipment at the lowest prices, with unbeatable service...compare our plug 'n play ease of use, warranties and return policies. Of course, Supercircuits microvideo is used by some of the biggest names in science, industry and national defense. But with prices starting at under \$40 for tiny high resolution video cameras, it is technology that is as affordable as it is amazing. Call us today, and get our free 72 page Microvideo Catalog, loaded with photos, specs and more.

Listed In Guinness Book of Records\*

1-800-335-9777 ext NV

Or fax us at 512-260-0444

One Supercircuits Plaza Leander, TX 78641

www.supercircuits.com

\*Supercircuits PC-21XP and PC-51XS are listed as world's smallest pinhole and spy video cameras

Write in 92 on Reader Service Card.

## Quality Computer Towers

AT Style Cases (Not ATX)

Full (260 Watt)(11 bays) \$35.00

Mid Size (230 Watt)(7 bays) \$20.00

## SCSI Hard Drives

New 2.1 Gig Seagate

\$80.00

New Micropolis 1.53 gig

\$50.00

IBM 4 Gig WIDE Differential

\$100.00 ea.



## Dealer Special

Designer Mouse

3 button Serial Mice

\$120.00 per case of 80



Color CCD Camera Project \$10.00

Lots of MicroWave Goodies in Stock

Brand New Wavetek 907AF Frequency Generators

Range 7-12.4 GHz \$900.00

HP Direct Reading Frequency Meter

#R532A 26.5-40 GHz New \$450.00

SMA Attenuators - Stepper Motors

## Electro Mavin

800-421-2442 or FAX 310-632-9867

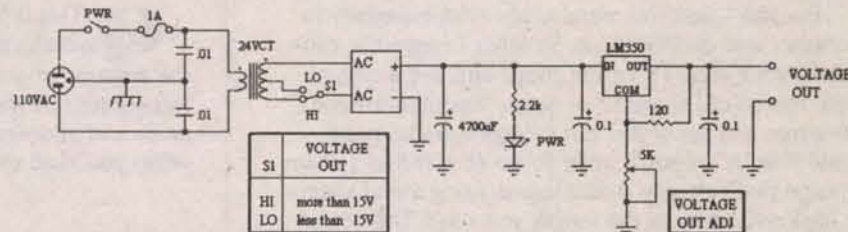
E-Mail John@mavin.com

Visit Our Web Site for More Info and Specials

http://www.mavin.com/mavin.html

## Electronics Q & A

Now for a solution to your heat problem. You mentioned adding a 60W bulb in series with the AC input to reduce heat (actually, I'd use a 25W bulb). Well, it'll reduce the heat generated by the LM350, but what about the heat the light bulb generates? Here's a better answer. The way you describe the power transformer, I'm sure it has a center tap, and I'm positive you're using a bridge rectifier, which means the center tap is unused. Simply break one of the AC secondary connections from the transformer to the bridge rectifier, and insert a HI/LO switch, as shown below.



For the convenience of our readers, I've included the rest of the schematic for the variable-voltage power supply, which can provide up to 3 amps at 30 volts. Anyway, when the switch is connected to the full secondary (HI position), the input voltage to the LM350 is 33.6 volts. In the LO position (center tap), the LM350 input voltage is 16.8 volts. If we run this voltage through our power and efficiency equations for 5 volts at 1 amp, we get a 12-volt drop across the regulator for a 12-watt power dissipation and an efficiency of 30%. Impressive, huh? All that for the cost of a switch. Shift the switch in the HI position for output voltages above 15 volts, and in the LO position for anything under 15 volts.

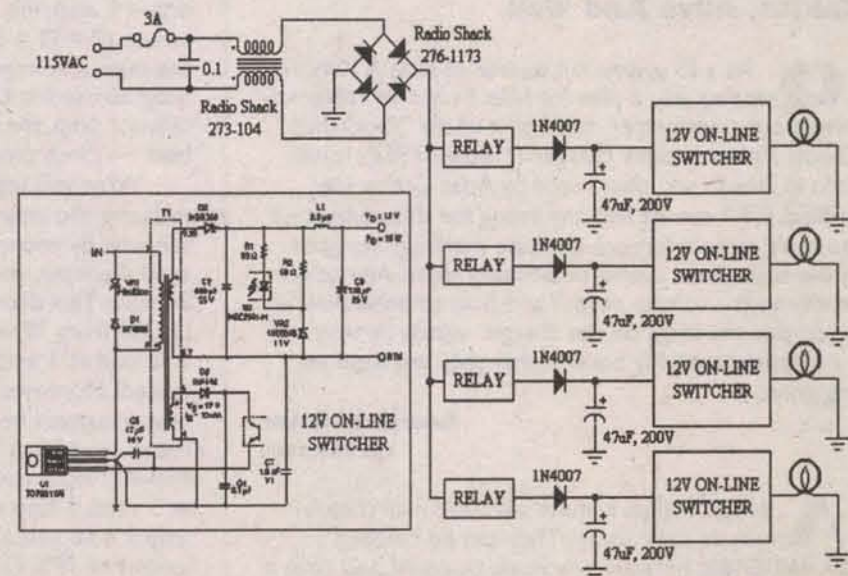
However, there are other solutions, specifically using a switching inverter in place of the transformer tap then inputting that voltage to the LM350, an arrangement that can push the efficiency to over 80%. Check out the "Switching Voltage Regulator Basics" series on page 76 for more details.

## Low-Power Off-Line Regulator

**Q** - I built a signaling device which uses four 12V, 1A bulbs and requires a large power transformer. I recently bought some low-voltage 60W halogen lights for my den that run off a very small wall transformer — or so I thought. Curiosity got the best of me, and I just had to open it up. Inside I found a small switching power supply that does everything my bulky transformers do! Can you show me how to build a simple switching power supply for my device? It uses solid-state relays to switch 12VAC.

Paul Frankle WD4LIQ via Internet

**A** - Like the question above, what you need is a switching voltage regulator. When working off an AC line, this type of converter is called an off-line regulator, and you'll find one in every desktop PC or workstation. Basically, what it does is convert the 115VAC into DC, run it through a pulse-width modulator, driving an isolation transformer, then rectify it into low-voltage, high-current DC. Your situation is unique in that you want low-voltage, high current AC because you're using incandescent lamps and triac-operated solid-state relays. That by itself puts some restrictions on the regulator because the frequency has to be within the switching range of the relay. In other words, the traditional 150 kHz off-line regulator moves too fast for your relays to react. What I'd do rather than switching the low-voltage is to make four 15W switching power supplies and turn them on and off as needed. Here's how it's done.





The circuit is based on a TOP201 switching regulator, a three-terminal device that needs just one external capacitor for flyback operation. The switching frequency is 100 kHz, and the transformer weighs just ounces. Oh, the transformer. Here it is.

Core Type:			
Siemens N67			
Part # 66208A	Number	Wire	
1110-T1	of turns	size	Comments
Primary	65T	AWG #32	Triple insulated
12V secondary	6T	AWG #26	Bifilar
Bias secondary	6T	AWG #24	Bifilar

For more information on winding off-line switching transformers, access **Power Integration's** website (<http://www.powerint.com>) and download the very informative "Flyback Transformer Design for TOPSwitch Power Supplies" and "TOPSwitch Flyback Transformer Construction Guide" application notes. You can buy the TOPSwitch regulators and transformer cores from **Component Distributors, Inc.** (800-777-7334; E-Mail: [sanjose@compdist.com](mailto:sanjose@compdist.com)).

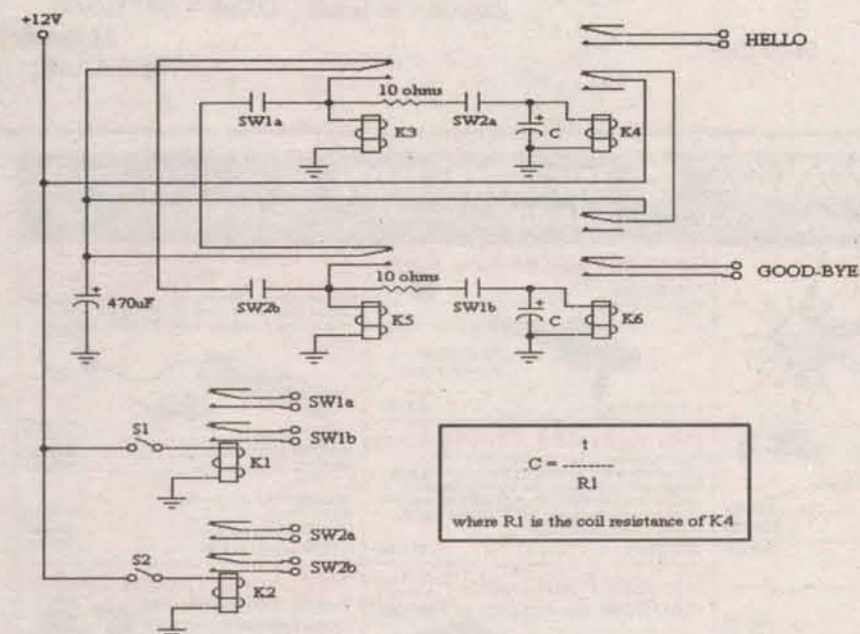
## You Say Good-Bye, And I Say Hello

**Q** - I am disabled and can no longer use my hands for such things as working with tiny parts, circuit boards, etc., but can still work with 14 gauge wires, with certain limitations. Therefore, I'm looking for an easy-to-connect pre-assembled switching unit to satisfy my needs.

I have a very simple driveway announcer system that sounds a car horn when a vehicle passes over a tape switch and closes the circuit. At present, the horn honks upon entering or exiting. I want a system to play one tape for 10 seconds upon entering and a different tape when exiting — kind of a "Hello" and "Good-bye" message. I want to expand my existing system such that there will be two tape switches (one at the very entrance and one 20' closer in), two audio tape players, and a switching unit, so that when a car pulls IN, the first tape player will be activated for about 10 seconds, and when the car pulls OUT, the other tape player would activate for about 10 seconds. Can you help?

Lane D. Honn  
Alamosa, CO

**A** - This design was challenging and quite refreshing because I had to use relays, which you can probably handle, instead of integrated circuit logic. Here's my answer.



The circuit consists of four relays wired in a set-reset flip-flop configuration. When switch S1 is closed, relay K1 pulls in and closes contacts SW1a and SW1b. This activates K3, which latches so that the relay won't drop out when S1 opens. This applies power to SW2a. When it is tripped, relay K4 pulls in and momentarily closes the contacts to the "HELLO" recording. At the same time, another set of K4 contacts breaks the power to K3, which now releases and resets the circuit for the next car. Relays K5 and K6 are wired identically, with the switches reversed so that SW2b activates the set relay (K5) and SW1b activates the reset relay (K6), which triggers the "GOOD-BYE" recording. To prevent the rear wheels from triggering SW1 again and starting the "HELLO" circuit, a capacitor is placed across K4 and K6. You'll need to measure the time it takes for a car to completely pass over the trip switch, then select the capacitor value using the formula  $C = t / R1$ , where R1 is the DC resistance of the relay. If it takes one-half second for the car to pass and the resistance of the

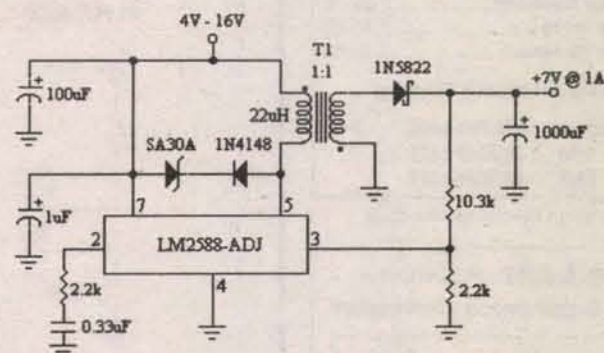
relay is 150 ohms (RadioShack 275-206), then the value of C is 3300uF. The 10-ohm resistor limits the surge current to the capacitor, which slowly discharges through the relay and temporarily holds it closed. As for the tape player, I recommend the Digital Voice Record and Playback Kit from RadioShack (276-1326). This prewired kit records and plays up to 20 seconds of sound — speech, music, sound effects, etc. — at the touch of a button or, in this case, a relay contact.

## Flyback Switching Regulator

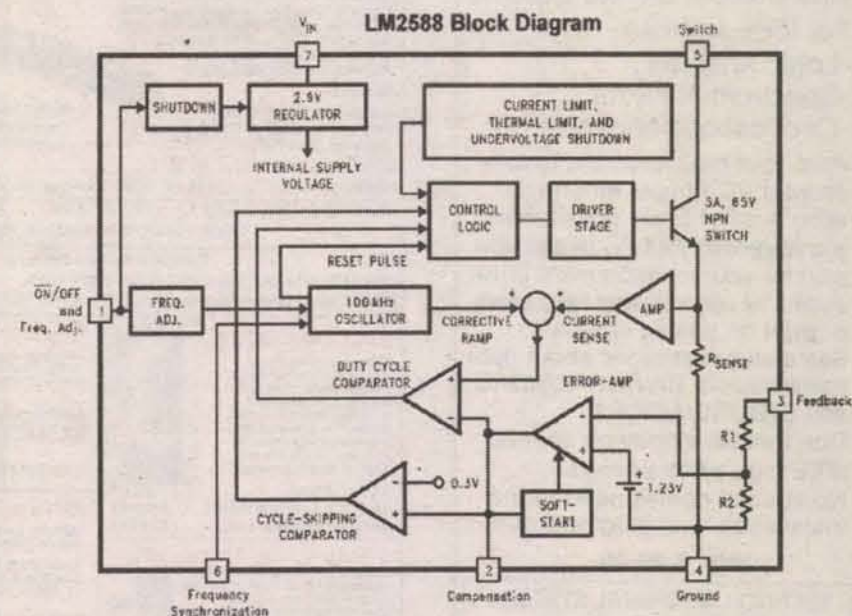
**Q** - I read with great interest your replies to the two DC-to-DC conversion queries in the Feb. '99 column. I would be interested to know what you'd recommend when the input voltage swings from 4 volts to 30 volts, yet the output has to be regulated at 7 volts  $\pm 10\%$ . How can I do this with some margin of safety in an automotive environment?

Will Byers  
via Internet

**A** - The answer is a switching voltage regulator configured in the flyback mode. I direct your attention to the companion article "Switching Voltage Regulator Basics — Part 2" on page 76. The flyback transformer does two things: It allows the input voltage to be either above or below the output voltage, plus it isolates the load from the power source — just what you need for an automotive environment. You didn't specify the current requirements, so (given the voltage) I suspect it's about 1 amp, in which case, I'd use the LM258x series of switching regulators from **National Semiconductor** (<http://www.national.com>). They are available from **Digi-Key** (800-344-4539; <http://www.digikey.com>) and **QuestLink** (<http://www.questlink.com>), and cost less than \$10. For this design, I've selected the LM2588, which has an input range of 4 to 40 volts and can switch up to 5 amps.



I chose this chip because it has a built-in NPN power transistor and requires a minimum number of external components. Also inside the chip is a 100-kHz oscillator that's used to turn the power transistor on and off. When the transistor is on, current flows through the primary winding, which builds up a magnetic field. When the transistor turns off, current flow ceases and the magnetic field collapses and transforms its energy to the secondary winding. The output is then rectified by a Schottky diode and filtered. The output voltage is held constant at 7 volts to within  $\pm 4\%$  via the feedback input (pin 3) and external divider resistors.



For Fixed Versions  
3.3V, R1 = 3.4k, R2 = 2k  
5.0V, R1 = 6.15k, R2 = 2k  
12V, R1 = 8.72k, R2 = 1k  
For Adj. Version  
R1 = Short (Dk), R2 = Open





The RF Connection  
213 North Frederick Ave.  
Suite 11NV  
Gaithersburg, MD USA  
20877

<http://www.therfc.com/>

Complete Selection of MIL-Spec Coax, RF Connectors and Relays

UG-21B/U N Male for RG-213/214.....\$5.00  
UG-21D/U N Male for RG-213/214.....\$3.25

N Connectors for 9913/Flexi4XL/9096

UG-21B/9913.....\$6.00 Pins Only.....\$1.50  
UG-21D/9913.....\$4.00 Extra Gasket......75

Amphenol 83-1SP-1050 PL-259.....\$0.90  
UG-176/U Reducer RG-59/8X .25 or 5/\$1.00  
UG-175/U Reducer RG-58/58A .25 or 5/\$1.00  
Silver Teflon PL-259/Gold Pin.....\$1.00 or 10/\$9.00

MIL-Spec Coax Available (Teflon, PVC IIA)

New Product: Belden 9913F. 9913 with High Density PE Foam dielectric, stranded center cond. and Duobond III Jacket..... .80/ft or \$76.00/100ft

Also New: 9092, RG8X with Type II Jacket Intro Price.....\$23.00/100ft

Call for Specials of the Month

Full Line of Audio Connectors for Icom, Kenwood, and Yaesu

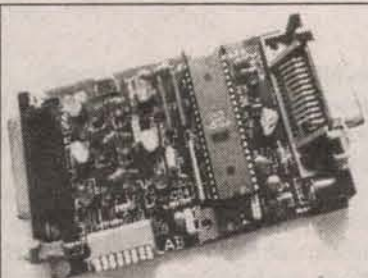
8 Pin Mike Female.....\$2.50  
8 Pin Mike Male Panel.....\$2.50  
13 Pin DIN for Kenwood.....\$2.75  
8 Pin DIN for Icom.....\$1.00  
8 Pin DIN for Kenwood.....\$1.50

Prices Do Not Include Shipping

Orders 800/783-2666  
Info 301/840-5477  
FAX 301/869-3680

Write in 93 on Reader Service Card.

## Techno Lab: PROCON-1 IEEE to Centronics Converter



more products: [TECHNO-LAB.com](http://TECHNO-LAB.com)

For IEEE sources:

-Logic Analyzer  
-Spectrum Analyzer  
-Oscilloscope and more

Print your measurement results on your PC Printer with never seen quality! Enjoy possibilities you have with your PC printer now also for your measurement print-outs! Use up to 50 feet long cable or print on plastic sheets! See status messages about data transmission: DAV/NRFD/NDAC and STROBE/ACK/PE. Don't waste money on special IEEE high price printers! No special cables needed, no installation- just plug and print!

only \$99.00

TECHNO LAB DIGITAL SYSTEMS  
1628 E Amar Rd Ste. L  
West Covina, CA 91792  
Phone: 626 964 1122  
Fax: 626 964 7962

38 Write in 94 on Reader Service Card.

## Electronics Q & A

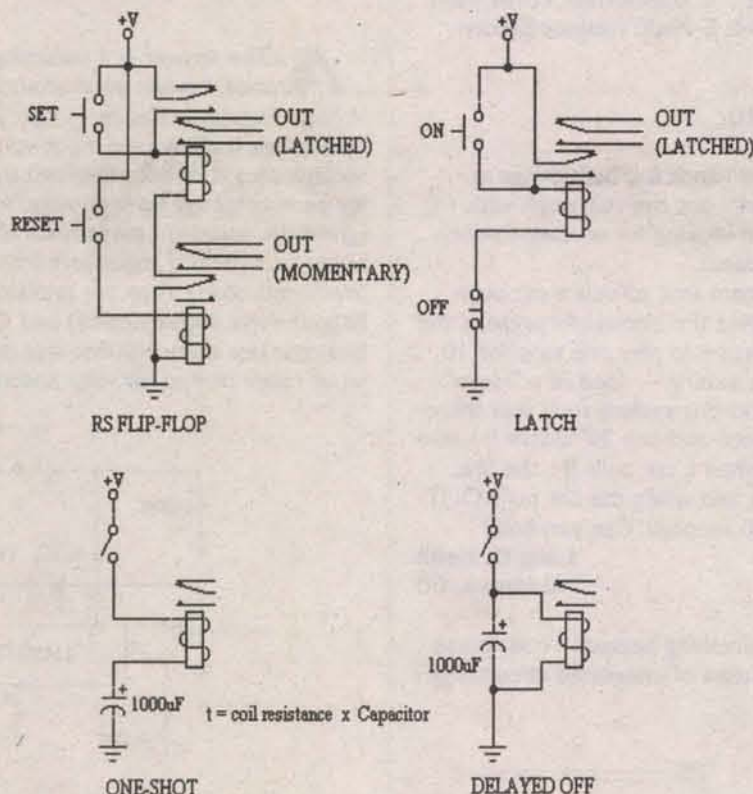
When building this circuit, you must attach the 1uF filter capacitor as close to pin 7 as possible, otherwise you risk damage to the regulator. The flyback transformer has a 1:1 turns ratio with a 22 uH primary, and is available from a number of vendors.

### LM2588 Flyback Transformer

Manufacturer	Part Number	Comments
Coilcraft	Q4434-B	
Coilcraft	Q4435-B	Surface mount
Pulse	PE-68411	Surface mount
Renco	RL-5530	
Schott	67141450	

### More Relays

Since Mr. Honn's question, I got into a relay mode for a couple days while playing with them again for the first time. I thought I'd pass on some other relay configurations that I've collected over the years that you might find useful.



The first circuit is an RS flip-flop. When the set button is pressed, the top relay pulls in and latches. Pressing the reset button engages the bottom relay, causing the top relay to drop out. The latching circuit next to it is somewhat similar, but only has a single relay and a single output. Pressing the "on" switch engages the relay and latches it; pressing "off" breaks the current flow and disengages the relay. The one-shot relay is identical to a monostable multivibrator or timer IC, like the 555. When the switch is turned on, current flows through the relay coil and capacitor, charging the capacitor. As the capacitor reaches full charge, the current isn't enough to sustain the relay, and the relay drops out. The delayed-off relay does the opposite: It holds the relay on for a short time after the switch is opened. When the switch is opened, the capacitor discharges through the relay coil and holds it closed. When the capacitor is fully discharged, the relay opens. The times for these two circuits are determined by the formula  $t = RC$ , where R is the resistance of the relay coil in ohms and C is the size of the capacitor in farads (1000uF = .001 farads).

TJ Byers  
Q & A Editor

## AMAZING PRODUCTS!

BOX 716 AMHERST, N.H. 03031

## INFORMATION

UNLIMITED deptadn599e

VISIT OUR "ACTION" WEB SITE@  
<http://www.amazing1.com>

### High Energy Pulsers

Experiment with and Construct: Rail Guns, Magnetic Launchers, Coil and Sleeve Guns, Super High Gravity Pulses, Explode Wires and Water, Antigravity, Levitation, Mass Warping, Magnetic Can Crushing, Plasma Propulsion, High Energy Radio Frequency Guns (Herf), EMP, Lattice Snapping, and all Types of Electrical Pyrotechnics, Plus Much More!!

Features:  
Lossless Induction Charging  
Programmable Energy Charging to 16 KJ  
Triggered Spark Switch

12vdc/115vac Input  
1 to 10KV Output\*  
Optional Designs Available

HEP3 Plans for 1 to 2KV @1 KJ.....\$15.00  
HEP3K Kit with 500J.....\$349.95 HEP30 Assembled Above.....\$449.95  
HEP9 Plans Higher Energy 1 to 10 KV @ 16 KJ.....\$20.00  
Custom Designs Available on Request

Complete System Projects  
PPRO1 Plasma Gun Plans With Above HEP3 Plans.....\$20.00  
MASS1 Mass Driver/Magnetic Cannon Plans With HEP3 Plans.....\$20.00

### Burning Laser Ray Gun

Blasts thru the Hardest of Metals

We Stock all Individual Parts

LAGUN2 Plans.....\$20.00

### Electronic Hypnosis/Mind Machines! TAKE CONTROL!!

Electronic Circuitry Induces Hypnotic as Well as ALPHA Relaxed States of the Mind. Place Subjects "Under Your Control. Enhances Hidden PSYCHIC Ability in Many People!!

MIND2 Plans.....\$15.00  
MIND2K Kit/Plans.....\$49.95  
MIND20 Ready to Use.....\$79.95

Intended For Hypnosis  
HYP2 Plans.....\$10.00  
HYP2K Kit/Plans.....\$49.95  
HYP20 Ready to Use.....\$69.95

### Jacobs Ladder

Observe a pyrotechnical display of "traveling" fiery plasma. Starts off as 1/2" arc and expands to over 3" before evaporating into space. This is an excellent attention getting display as well as a winning science project!! With arc control.

JACK1 Plans.....\$8.00  
JACK1K Kit Minus Case.....\$129.95  
JACK10 Ready to Use.....\$249.95

### Cybernetic Ear!

Enhances Normal Hearing 3 to 4 Times. Provides That Extra "Edge" Hunters Trackers Nature Enthusiast

Adjustable Volume Control  
Fits into Either Ear  
Built in Long Lasting Batteries

CYBEREAR.....\$19.95

### Micro Tesla Coil

Lights up a 4 ft Fluorescent Tube Without Contact!!! Yet Only 3" Tall!

Super Magic Trick  
Low Cost Science Project  
12 VDC/115 VAC Operation

MTC1K Kit/Plans.....\$24.95  
MTC10 Assembled.....\$34.95

### Hover Boards

28 Pages of "how to" build a magnetic force field capable of containing a column of ionized air up to several psi! Includes theory on how to build a HOVERBOARD prototype capable of lifting 200 lbs.

HOVER Plans and Data.....\$25.00

### Phaser Pain Field Pistol

CAUTION! Do Not Aim at People!

Blast out rats and other rodents with high powered ultrasonics

Handheld and battery operated with all controls

Rental units available

PPP1 Plans.....\$8.00  
PPP1K Kit/Plans.....\$49.50  
PPP10 Ready to Use.....\$79.50

### Telephone Taping System

Extends Taping Time by X4. Automatically tapes both sides of phone conversation-Check Laws!

TAPE30X Ready to Use.....\$84.95  
BEEP10 Beeper Alert.....\$29.95

### Transistorized TESLA Coil

Amazing and Bizarre Effects Turn a Normal Light Bulb into a Spectacular Plasma Display!! Excellent Science Project

Transmits Wireless Energy  
Noiseless Operation  
Pyrotechnic Effect  
12 VDC/5 Amps or Battery  
Adjustable Frequency  
Control For Effect

Note: Assembled Units May Vary in Final Housing and Layout. Kit is Shown.

TCL5. Plans.....\$8.00 TCL5K Kit/Plans.....\$59.50  
TCL50. Assembled and Tested.....\$99.50  
12DC/7. 12VDC@7Amps Supply.....\$39.50

1 800 221 1705 Orders Only! Fax 1 603 672 5406 Information 1 603 673 6493 Free Catalog on Request

Pay by MC,VISA,Cash, Check, MO, COD. Please Add \$5.00 S&H plus \$5.00 if COD. Overseas Please Contact for Proforma

Write in 98 on Reader Service Card.



## HAM GEAR FOR SALE

**HAM EQUIPMENT** repair or overhaul Collins, Drake, Swan, Astro, Yaesu, Kenwood, etc. 20 years experience with former Slep Electronics Co. Same excellent service, same reasonable rates, satisfaction guaranteed. Brooks Electronics, 828-349-3503. E-Mail: [rwbrooks@dnet.net](mailto:rwbrooks@dnet.net)

**WANTED: ROCKWELL**-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), [bfl-jfs@smartlink.net](mailto:bfl-jfs@smartlink.net)

**NEW 1999** catalog: Inductors, toroids, TC ceramic and Mica capacitors, semi-conductors, wire and cable, hardware, more. Two stamps please. Johnson Shop Products, Box 2843, Cupertino, CA 95015.



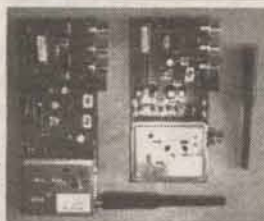
**THE SMART BATTERY CHARGER** for lead acid or gel cell batteries. Can be left connected to the battery **INDEFINITELY**, will not overcharge! Standard kit is 12V @ 1 amp. This kit is 100% complete. For the kit order #150-KIT at \$59.95. For an assembled and tested unit, order #150-ASY at \$79.95. CA residents add 7.75% sales tax. Add \$6.50 per unit shipping. MC/VISA accepted. A&A Engineering, 2521 W. La Palma #K, Anaheim, CA 92801. 714-952-2114, FAX 714-952-3280.



**MIKEMASTER:** A microphone preamplifier with noise gating & compression. Created by Marv Gonsior W6FR, March 1998 QST. Got noise get MikeMaster! For kit order #210-KIT at \$69.95. Assembled & tested (specify Kenwood, ICOM, or Yaesu wiring) order #210-ASY at \$89.95. Shipping for US & Canada is \$6.50, others add 15%. CA residents add 7.75% sales tax. For info send legal size SASE to A&A Engineering, 2521 W. LaPalma #K, Anaheim, CA 92801. P 714-952-2114, Fax 714-952-3280.

**LML RADIO & electronic.** Let us be your one stop shop. Let us be your one stop shop for all brand's of commercial & CB radio equipment, test equipment & other surplus. Free catalog 909-873-1319. Fax on demand 24 hr. 909-820-1885. Web catalog <http://members.aol.com/hrh6> Write: 424 E. Shamrock, Rialto, CA 92376.

**NEW PRODUCTS FROM S & S: UPGRADE YOUR OLD RIGS!** Digital dial (counter) has 10Hz resolution HF, 100Hz VHF and frequency range 50KHz to 230MHz; kit \$99.95; assembled \$149.95. **NEW Digital VFO** with 1Hz resolution to 54MHz; kit \$169.95; assembled \$219.95. S&H \$7 (Continental US). **GUARANTEED TO WORK.** For info send SASE. Call/write to order: S & S Engineering, 14102 Brown Rd., Smithsburg, MD 21783. 301-416-0661, E-Mail: [N3SAD@aol.com](mailto:N3SAD@aol.com) or see <http://www.xmetric.com/sseng>



**2.4 GHz/1.2 GHz VIDEO TRANSMITTER & RECEIVER** designed exclusively for HAM ATV bands. 8 switchable frequencies; F/SMA type connectors with two 1/4 wave rubber-duck antennas included; 100 mw output power. Receiver has greater than -80 dB sensitivity. **Price \$119.** Related camera, video, and security systems also available. Two additional audio channels can be used for digital data applications. Due to high response, please contact by E-Mail: [info@4atv.com](mailto:info@4atv.com) Website: [www.4atv.com](http://www.4atv.com)

## HAM GEAR WANTED

### CB - SCANNERS

**FREE CATALOG:** hobby radio books; frequencies, modifications, repairs, upgrades, maintenance & more! Largest source of monitoring books available in one catalog! CRB, PO Box 56-NV, Commack, NY US 11725. Phone: 516-543-9169, 9-3, M-F. Fax: 516-543-7486. E-Mail: [catalog@crbbooks.com](mailto:catalog@crbbooks.com)

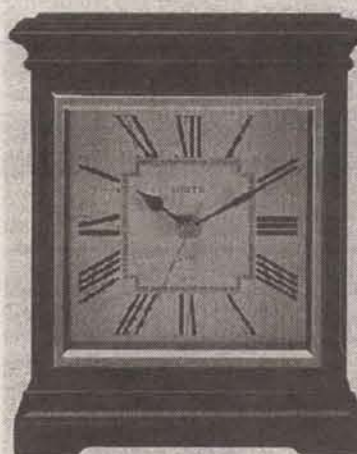
**ABC ELECTRONICS** 315 7TH AVE N. MPLS. MN. 55401  
(612)332-2378 FAX (612)332-8481 E-MAILS [SURP1@VISI.COM](mailto:SURP1@VISI.COM)  
**WE BUY TEST EQUIPMENT AND COMPONENTS.**  
**VISIT US ON THE WEB AT [WWW.ABCTEST.COM](http://WWW.ABCTEST.COM)**

HP 34501A 100MHZ DIGITIZING SCOPE	\$1300.00	HP 4935A TRANS. IMPAIRMENT TEST SET	\$900.00
HP 34201D 300MHZ DIGITIZING SCOPE	\$1000.00	HP 5006A SIGNATURE ANALYZER	\$150.00
HP 34201A 300MHZ DIGITIZING SCOPE	\$1000.00	HP 86602B 1MHZ-1300MHZ RF PLUG	\$400.00
HP 54200A 50MHZ SCOPE/WAVEFORM ANALYZER	\$700.00	EIP 375 MICROWAVE COUNTER	\$1500.00
HP 3312A 13MHZ FUNCTION GENERATOR	\$250.00	FLUKE 95 50MHZ SCOPEMETER	\$350.00
HP 5370A 100MHZ U.T.I. COUNTER	\$400.00	LECROY 7200 400MHZ O-SCOPE	\$1000.00
HP 3586C LEVEL METER	\$750.00	TEK 475 200MHZ O-SCOPE	\$500.00
HP 436A POWER METER W/O SENSOR&CABLE	\$500.00	TEK 465 100MHZ O-SCOPE	\$400.00
HP 8350B SWEEP OSCILLATOR MAINFRAME	\$2000.00	TEK 496P 1KHZ-1.8GHZ SPEC. ANALYZER	\$3500.00
HP 3437A 3.5DIGIT SYSTEM VOLT METER	\$250.00	TEK 1240 LOGIC ANALYZER	\$750.00
HP 3455A DIGITAL MULTIMETER	\$250.00	TEK TDS320 100MHZ DIGITAL O-SCOPE	\$1400.00
HP 3456A DIGITAL MULTIMETER	\$400.00	TEK 11401A 500MHZ PROG. O-SCOPE FRAME	\$750.00
HP 3336C SYNTHESIZER/LEVEL GENERATOR	\$800.00	TEK 7854 400MHZ OSCILLOSCOPE FRAME	\$500.00
HP 3325A SYNTHESIZER/FUNCTION GENERATOR	\$1000.00	TEK 7904 400MHZ OSCILLOSCOPE FRAME	\$250.00
HP 5335A 200MHZ COUNTER	\$600.00	TEK 7A26 200MHZ VERTICAL PLUG	\$75.00
HP 8165A PROGRAMMABLE SIGNAL SOURCE	\$1100.00	TEK 7A24 400MHZ VERTICAL PLUG	\$150.00
HP 8558B/181 100K-1500MHZ SPECTRUM ANALYZER	\$1000.00	TEK 7B80 400MHZ TIME BASE	\$75.00
HP 8559B/183 10MHZ-21GHZ SPECTRUM ANALYZER	\$3000.00	TEK 7B92A 500MHZ DUAL TIME BASE	\$125.00
HP 1740A 100MHZ OSCILLOSCOPE	\$250.00	TEK 7S12 SAMPLING PLUG	\$250.00
HP 6034A 60VDC-10A POWER SUPPLY	\$750.00	TEK 7L14 10KHZ-1.8GHZ SPEC. ANALYZER	\$1000.00
HP 6269B 40VDC-50A POWER SUPPLY	\$800.00	TEK AM503 CURRENT PROBE AMPLIFIER	\$250.00
HP 6533A 40VDC-12.5A POWER SUPPLY OPT J01	\$1200.00	WAVETEK 145 20MHZ PULSE/FUNCTION GEN.	\$400.00
HP 6632A 20VDC-5A POWER SUPPLY	\$500.00	WAVETEK 182A 4MHZ FUNCTION GEN.	\$150.00
HP 6643A 45VDC-4.3A POWER SUPPLY OPT J03	\$750.00	WAVETEK 955 7.5-12.4GHZ MICROSOURCE	\$1100.00

Write In 62 on Reader Service Card.

# Surveillance

## Only Japanese Color Cameras



Mahogany Clock Cam \$250

Sale Ends 7/15/99

BC-985 Color Board Camera	\$125
BC-985P Pinhole Lens Camera	\$145
BX-985 Black Box Camera	\$155
SD-985 Smoke Detector Cam	\$195
EX-985 Exit Sign Cam	\$195
EL-985 Emergency Light Cam	\$225
PS-985 Pencil Sharpener Cam	\$225
CL-985 Carriage Clock Cam	\$250
VB-985 Video Bag w/12 hour Battery Pack and Charger	\$295
VP-400 Video Pen w/ 2 hour Battery Pack and Charger	\$1500

### Color Camera Specifications

High Resolution -- Over 380 TV lines  
Low Light Sensitivity -- Only 2 Lux  
Built-In Backlight Compensation  
1 Year Limited Warranty

American Innovations, Inc.  
383 West Route 59  
Spring Valley, NY 10977

M-F 11:00 - 8:00 P.M.  
Sat. 12:00 - 6:00 P.M.  
Tel (1) 914-371-3333  
Fax (1) 914-371-3885

[www.spysite.com](http://www.spysite.com)

Write in 64 on Reader Service Card.

## JUST ABOUT EVERYTHING YOU NEED FOR FAXES & PRINTERS IS AT ONE CONVENIENT ADDRESS:

**[www.faxrepair.com](http://www.faxrepair.com)**

**For service, parts & sales, Cyber-Test is America's Largest Fax Support Center.**

- **CIRCUIT BOARD REPAIR** Component level repair on boards and power supplies for all brands & all models.
- **ENTIRE MACHINE REPAIR** We fix any thermal, ink jet or laser fax. Low flat rates available!
- **PARTS** We have a huge inventory of new & refurbished fax and printer parts ready to ship. Easy ordering with no part number necessary. H-P laser parts available!
- **SALES** Great deals on commercial grade plain paper faxes.
- **SUPPLIES** Drums, toner & developer for laser faxes or printers. Lowest prices anywhere for Okidata, AT&T, DEX and Samsung!
- **SUPPORT** Why go anywhere else? Check our Web Site or call today!



**800-881-3344**

press "6" for repair & sales  
448 Commerce Way - Bldg. 100 - Longwood, FL 32750

Write In 63 on Reader Service Card.



**KONNEX DISTRIBUTING.** Call 1-888-777-7874. PO Box 451372, Los Angeles, CA 90045. CBs, antennas, meters, transistors. Best prices. Credit card acceptable.

**MESSENGER, RED Devil,** Shooting Star, Palomar, Superstar, Uniden, CB radios, microphones, exports, Galaxy, etc., more! 5 page picture price sheets \$1 (refundable) scanners too!! Galaxy, Box 1202, Akron, OH 44309. Over 15 yrs. in business!

**HALCON COMMUNICATIONS**  
Wholesale only: Cobra, Uniden, Midland, Galaxy, CTE, Super Star, Kenwood, Yaesu, Icom. Free catalog, Free call 1-800-683-6999.

**240+ CHANNEL CB/HAM/COMMER-**  
CIAL radios: AM/FM/SSB/CW export/domestic: RCI, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linears, meters, books, night scopes, and tons more stuff! Catalog \$3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244.

**CB MODIFICATIONS!** Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog \$3. CBCI, Box 1898NV, Monterey, CA 93942. [www.cbciintl.com](http://www.cbciintl.com)

**SCANNING USA:** monthly magazine 100% scanning. All the news and product reviews from the writers you trust. Get more from your scanner. Subscriptions \$24.95, samples \$3. Call 1-800-651-0922 your Visa or MasterCard, or write 2054 Hawthorne, Joliet, IL 60435

**SALES, SERVICE:** CB equipment, radios, modifications, power mice, echo-reverb boxes, kits, meters, filters, antennas, noise toys, mounts, hard-to-find items. Partial list \$1, complete list \$4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 860-283-9492.

**See Us On The Web [www.nutsvolts.com](http://www.nutsvolts.com)**

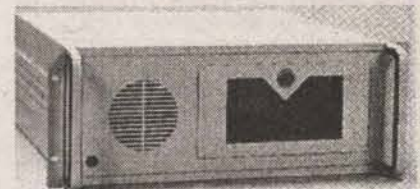
## MUSIC & ACCESSORIES

**WANTED: OLD** guitars/tube amps. Fender, Gibson Vox, Gretsch, Rickenbacker, Martin, etc. 405-737-3312 fax 405-737-3355. E-Mail: [SonnySound@aol.com](mailto:SonnySound@aol.com)

## COMPUTER HARDWARE

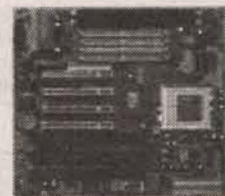
**WE CARRY** a variety of cables, switch boxes, accessories, and adapters to connect PCs, printers, Mac's, networks, telecommunications, and audio/video equipment. We offer: custom cables, free catalogs, and same day shipping on most orders. Visit our website at [www.rogerssystems.com](http://www.rogerssystems.com) or call 1-800-366-0579.

**CRTs CHEAP.** Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty.** Reg-Res 19" tubes \$75; 25" \$100; hi-res 13" tubes from \$80. We specialize in **hi-resolution video/computer CRTs.** T.M.C. 215-226-0749/215-223-0388.



**19" RACKMOUNT PC chassis:** Heavy duty, 4U, for standard 7 slots ATX motherboard. Four (three hidden) 3.5"/two 5.25" drive bays, power supply not included, \$169 with this ad! Add \$6 for 7 slots AT conversion kits. Monitor chassis \$229, keyboard chassis \$129. 8255-8253 I/O card with prototyping area \$69, 12-bit ADDA card \$89. **Computronics Technology**, 972-242-8087, [www.cti-texas.com](http://www.cti-texas.com)

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.



**333MHz MMX CPU w/fan & TX-Pro II motherboard,** 4 megabyte AGP video, 3D 32 voice sound, 2 PCI Ultra DMA IDE ports, 4 72 pin EDO/FP & 2 168 pin DIMM/SDIMM sockets, 2 serial, 1 parallel, 2 USB, PS/2, infrared ports, ATX or normal power, 2 year warranty, combo deal only \$129. Similar as above, but with 366MHz Intel CELERON/A 128K cache Pentium II CPU, Intel jumperless i440LX/EX AGP chipset, 3D 8MB video, 56K modem/fax/voicemail \$209. **847-657-1160 or [www.saveware.com](http://www.saveware.com)**

**SONY PLAYSTATION GAME-ENHANCER, Play backups/imports.** No messy soldering of mod-chip and breaking the warranty, simply plug the enhancer into your playstation! Skips both Sony Logos on bootup! The power to bust your games wide open!! Just imagine, infinite lives, unlimited energy, extra levels, hidden levels! Optional communications package to connect to your PC! View any file on CD, copy memory cards and much, much more! \$35. **847-657-1160 or [www.saveware.com](http://www.saveware.com)**

**27pc•kit**

**\$12.95**

**K2637  
MINIATURE AUDIO AMPLIFIER KIT**  
Big sound from a small unit!  
Small PCB with both pre- and power amp  
Short circuit protected  
Input sensitivity: 20mV  
Max. output power: 2.5W  
Power supply: 4.5 to 15VDC



**28pc•kit**

**K1771  
FM OSCILLATOR KIT**  
Use for home broadcasts, baby monitoring, security  
Frequency range: 100-108MHz  
Microphone input  
No coils to wind  
Power supply: 9-12VDC



**17pc•kit**

**\$9.95**

**K1803  
UNIVERSAL MONO  
PRE-AMPLIFIER KIT**  
Boost any audio signal  
up to 40dB (x100)  
Max input signal: 40mV  
Frequency range: 20Hz to 20KHz  
Power supply: 10-30VDC/10mA



**19pc•kit**

**\$19.95**

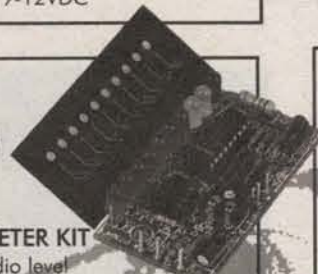
**K5300  
STROBOSCOPE KIT**  
Stage effects at home  
Adjustable flash rate: 2-20  
flashes/second  
Powerful flash tube  
Supply voltage: 110-125V AC



**36pc•kit**

**\$18.95**

**K4304  
10 LED VU METER KIT**  
Visualise any audio level  
Line or speaker inputs  
DOT or BAR mode. Range: -20 to +3dB  
Front-panel included. Vertical or horizontal  
mounting. Power supply: 10-15VDC



**27pc•kit**

**\$24.95**

**K5002  
HALOGEN  
LAMP DIMMER KIT**  
Light control at the touch of a button  
Suitable for loads up to 3A  
Can control small motors with brushes  
Push button operation  
Add any number of buttons  
Power supply: 110-125V AC



**16pc•kit**

**\$14.95**

**K6708  
IR REMOTE  
CONTROL KEY CHAIN  
TRANSMITTER** For K6709 Kit  
Range: Up to 24 feet  
LED operation indicator  
8748 different code settings  
Power supply: 12V battery



**66pc•kit**

**\$24.95**

**K6709  
IR REMOTE  
RECEIVER**  
For K6708 Kit  
The easy way to add a remote control  
10A relay with norm. or pulse changeover contact  
Allows control of alarm systems, garage doors,  
outdoor lighting, garden pumps, etc.  
LED reception indicator  
Accepts multiple transmitters K6708  
Power supply: 2x9VAC or 12 to 16VDC



**12pc•kit**

**\$12.95**

**K1823  
1 AMP  
POWER SUPPLY**  
Just add a transformer  
Adjustable output voltage  
1.5V to 35V/1A max.  
Short circuit and thermal protection  
Max input voltage: 37VDC  
Max dissipation: 15W



**18pc•kit**

**\$14.95**

**K6700  
2-WIRE REMOTE  
CONTROL TRANSMITTER**  
Transmitter For K6701 Kit  
Control up to 16 devices\*, with  
only 2 wires! Remotely control 8  
(\*16 with 2 units) devices up to  
160 feet away. Transmitter is powered  
over the data wires. Simple operation by  
means of switches (not included)  
Transmitter can drive multiple receivers



**K6701  
2-WIRE REMOTE CONTROL  
RECEIVER** For K6700 Kit  
8 open collector outputs (max 200mA)  
LED output status indication  
Daisy chain 2 units for 16 outputs  
Power supply: 6-16V DC

**46pc•kit**

**\$24.95**

**18pc•kit**

**\$14.95**

**K2579  
UNIVERSAL START STOP TIMER KIT**  
0-15 Minutes Adjustable Delay  
3A changeover relay contact  
Start and Stop button included  
LED function indicator  
Can be modified for longer delays  
Power supply: 12V/55mA



# velleman

7415 Whitehall Street Suite 119  
Fort Worth, TX 76118  
(817) 284-7785 F: (817) 284-7712  
[www.velleman.be](http://www.velleman.be) email: [velleman@earthlink.net](mailto:velleman@earthlink.net)

Questions? Contact us for a list of US distributors or to get your **FREE** catalogue



# LASERS & ACCESSORIES

## HELIUM NEON LASERS

- ✓ Complete Systems
- ✓ Plasma Tubes
- ✓ Power Supplies

## ACCESSORIES

- ✓ Optics
- ✓ Electro-Optics
- ✓ IR Viewers
- ✓ Books & More



**MEREDITH**  
INSTRUMENTS

Phone: 602-934-9387 • Fax: 602-934-9482

## DIODE LASERS

- ✓ Visible / IR
- ✓ Complete Modules
- ✓ Collimating Optics
- ✓ Drive Circuits

## FREE CATALOG

WEB SITE:  
**www.mi-lasers.com**

Write in 65 on Reader Service Card.



**333MHz MMX system w/4.3 gigabyte hard drive, 44X CD-ROM, 1.44 floppy, 32 megabyte SDIMM memory, AGP 4 megabyte video, 56K modem/voice/fax, 3D 32 voice sound, 200 watt speakers, enhanced multimedia keyboard, Internet scroll mouse, mini-mid sliding door case, 2 year parts and labor warranty. Only \$459! Same as above, but with 366MHz Intel CELERON/A 128K cache Pentium II CPU and Intel jumperless i440LX/EX AGP chipset motherboard with 3D 8MB video, mid ATX case \$599. Installed FULL versions WIN95B \$59, WIN98 \$119, 847-657-1160 or [www.saveware.com](http://www.saveware.com)**



**CABLE READY TV card with capture and remote \$89. USB cables: ATX form card 18 pin header, 2 USB, 1 PS/2, 1 IF \$15. 16 pin 2 USB \$17. 10 pin (2 5 pin) \$19. 847-657-1160 or [www.saveware.com](http://www.saveware.com)**

**NewComputer.com! OVER 50,000 hardware and software products. Orders over \$500 shipped free. Our unique product categories and search features let you quickly locate the item you're looking for. The next time you need computer equipment, try NewComputer.com**

**BUILD YOUR own Pentium Computer and save money or start a small business with a 79 min video tape. It's easy when you know how! Limited supplies. \$29 (reg. \$59.95) Call: 1-800-754-5096 for details!**

## COMPUTER SOFTWARE

**GAME WIZARD** cartridge for PlayStation. Works like a mod chip and the best cheat cartridge all in one. It will use all the same cheat codes the others use. Only \$29.95 free shipping. Toll Free 1-888-467-6150 all credit cards accepted. [www.computerconnectionusa.com](http://www.computerconnectionusa.com)

**MICROSOFT OFFICE97** Professional Edition. New factory sealed, unopened. CD only. The **STANDARD** word processor, database, spreadsheet, much more. Only \$49.95! While they last. **FREE SHIPPING.** [bruce.sullivan@msn.com](mailto:bruce.sullivan@msn.com)

**FREE IBM DISK CATALOG** of quality Shareware and CD-ROMs. **MOM 'N' POP'S SOFTWARE <ASP>**, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108. [momnpop@gate.net](mailto:momnpop@gate.net)

**CAM & MOTION SW/HW:** Z-trace, PCB toolpath. Plotcam motion control, step drivers. [cmheater@juno.com](mailto:cmheater@juno.com) MSG/FAX 407-452-7197, 407-459-2729. [www.megabits.net/ddt](http://www.megabits.net/ddt)

**LINUX & FREEBSD & LINUX & FREEBSD** Linux and FreeBSD distributions on CD-ROM for as low as \$1.99. See our full range of Linux products and books at **incredible prices**. Use our secured shopping cart system at [www.cheapbytes.com](http://www.cheapbytes.com) Visa and MasterCard gladly accepted. E-Mail: [sales@cheapbytes.com](mailto:sales@cheapbytes.com) fax: 209-367-8518. CheapBytes, PO Box 2714, Lodi, CA 95241.

**STEALTH MOD** chips for Sony PlayStation. Now even your anti-mod games will work. Only \$9.95 ea. + \$3.35 shipping. Call Toll Free 1-888-467-6150. All credit cards accepted. [www.computerconnectionusa.com](http://www.computerconnectionusa.com)

## COMPUTER EQUIPMENT WANTED

**WANTED: FOR** historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

**WANTED: HPI5C** calculators. Will pay. Call Hugh Adams 850-864-2414.

**WANTED: TERMINALS + PRINTERS:** DEC, Wyse, IBM, ADDS, Okidata, Data South, Epson, C.I.T.O.H., etc. Call for quote on any surplus computer equipment. Call Jeremy, 603-673-8077.

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dialog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

**HOBBYIST SEEKS** Altair 680, 8800, or Imjai 8080 computer, any condition. Call Shawn, 650-846-8208. [maxweb@pacbell.net](mailto:maxweb@pacbell.net)

**HP CALCULATORS** wanted: models 10, 70, calculator watch, others for private collection. Cash paid. Bob Morrow, 765-855-2348, [rkmorrow@aol.com](mailto:rkmorrow@aol.com)

**Sell Nuts & Volts in your store!** Contact us for complete details. phone 909-371-8497 fax 909-371-3052 E-Mail [distributors@nutsvolts.com](mailto:distributors@nutsvolts.com)

# Go Wireless With Our Modules

## SILRX/TXM

SILRX — \$26.00 ea.  
TXM — \$15.50 ea.

The TXM and SILRX modules are a transmitter and receiver pair which can achieve a one-way radio data link-up to a distance of 200m over open ground.

Both units are supplied in space-saving single-in-line packages and offer SAW controlled, wide band FM transmission/reception.

The modules are particularly suited to battery-powered, portable applications where low power and small size are critical design criteria.



## TX2/RX2

TX2 — \$19.50 ea.  
RX2 — \$38.50 ea.

The TX2 and RX2 radio transmitter and receiver pair enable the simple implementation of a data link at up to 40kbit/s at distances up to 75m in-building and 300m open ground. Both modules combine full screening with extensive internal filtering to ensure EMC compliance by minimizing spurious radiations and susceptibilities. The TX2 and RX2 modules will suit one-to-one and multinode wireless links in applications including car and building security, EPOS and inventory tracking, remote industrial process monitoring, and computer networking.

Because of their small size and low power requirements, both modules are ideal for use in portable, battery-powered applications such as hand-held terminals.



900 MHz

AVAILABLE JAN '99

## RPC

RPC — \$99.00 ea.

The RPC module is an intelligent transceiver which enables a radio network link to be simply implemented between a number of digital devices. The module combines an RF circuit with processor-intensive low-level packet formatting and recovery functionality, requiring only a simple antenna and 5V supply to operate with a microcontroller or a PC.



## BiM

BiM — \$69.00 ea.

The BiM module integrates a low-power UHF FM transmitter and matching superhet receiver together with data recovery and TX/RX change over circuits to provide a low-cost solution to implementing a bi-directional short-range radio data link.



## Lemos International Co., Inc.

65 Southbridge Street, Auburn, MA 01501

Phone (508) 798-5004 ♦ Fax (508) 798-4782

[www.lemosint.com](http://www.lemosint.com) ♦ [lemosint@ma.ultranet.com](mailto:lemosint@ma.ultranet.com)

All products available in either 418 or 433 MHz

Write in 66 on Reader Service Card.

## E-Math Pro Windows version!

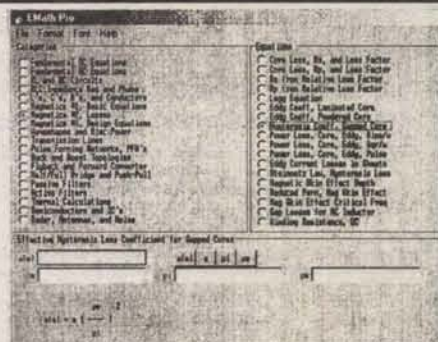
E-Math is the Essential Formula Tool for Engineers, Technicians, and Students.

### Features

- Over 300 formulas
- Ability to rotate equations.
- Solve for any variable.
- Help for each equation.
- Win95, Win98, NT compatible

### Formula Categories:

- (A) Fundamental DC Formulas
- (B) Fundamental AC Formulas
- (C) RL and RC Circuits
- (D) RLC Impedance Magnitude and Phase
- (E) L's, C's, R's and Conductors
- (F) Magnetics #1, Basic Equations
- (G) Magnetics #2, Losses
- (H) Magnetics #3, Design Equations
- (I) Waveshapes and Miscellaneous Power
- (J) Transmission Lines
- (K) Pulse Forming Networks
- (L) Buck and Boost Topologies
- (M) Flyback and Forward Converters
- (N) Half/Full Bridge and Push-Pull Topologies
- (O) Passive Filters
- (P) Active Filters
- (Q) Thermal Calculations
- (R) Semiconductors and Integrated Circuits
- (S) Radar, Antennas and Noise



**E-Math Pro Windows v1.0**  
**\$49.95**

### Bytech Services

[www.bytechservices.com](http://www.bytechservices.com)  
US Toll-free: 1-888-422-7521  
Voice/FAX (360) 422-7520

Dealer and Distributor  
inquiries — YES



**Bytech Services**

Write in 67 on Reader Service Card.



## TEST EQUIPMENT

**FEITEK PROVIDES** repair, calibration and traceable certifications of test equipment. Free estimates. We buy, sell and trade all makes of test equipment. Visa and MasterCard accepted. Check out our inventory and specials at [WWW.FEITEK.COM](http://WWW.FEITEK.COM) 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

**SPECTRUM ANALYZER** in a probe. \$249. View thru your inexpensive scope. [WWW.spectrumprobe.com](http://WWW.spectrumprobe.com)

**KENTRONIX TEST EQUIPMENT SPECIALS.** Check our WEB site at <http://www.kentronix.com> for monthly specials. We are also looking to buy test equipment, coaxial and waveguide components, manuals, etc. Contact Brian at 732-681-3229 or FAX 732-681-3312. E-Mail: [brian@kentronix.com](mailto:brian@kentronix.com)

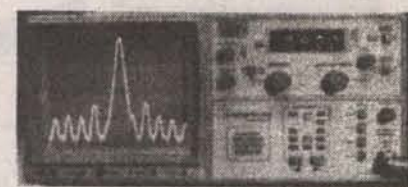
**AFFORDABLE HP** power sensor repair! Most 8481As repaired for \$255 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

**TEST EQUIPMENT FOR SALE:** [HTTP://WWW.A-COMM.COM](http://WWW.A-COMM.COM)

**HP 4815A Z-meter:** Sandford Associates. TOTAL service specialist. Repairs warranted to HP/QA factory specs. Former HP tech/supv with expertise, parts, and tooling. Tel/fax: 908-852-7989, E-Mail: [GeoSA4815@compuserve.com](mailto:GeoSA4815@compuserve.com)

**POOR MAN'S** Spectrum Analyzer/Monitor Receiver Kit. 2 to 1,700 MHz. Basic kit only \$78. Now available with switched resolution filters, tracking generator and direct digital frequency readout. Works with ANY scope or IBM compatible computer. Send stamped envelope for details. Science Workshop, Box 310B, Bethpage, NY 11714. <http://www.science-workshop.com>

**BRUEL & KJAER BUY, SELL, BEST PRICES.** EXCALIBUR ENGINEERING, 3198-C AIRPORT LOOP DRIVE, COSTA MESA, CA 92626. 714-540-0169, FAX 714-540-5417.



**ENGINEER TESTED:** Spectrum analyzers, frequency counters, frequency standards, meters, scopes, generators, curve tracers, and more. **VISA, MASTERCARD, AMEX.** "Performance tested." NIST calibrated. Warranted. New & used. Gary N6ZD. [HTTP://TECH-SERVICES.COM](http://TECH-SERVICES.COM) 831-385-7519.

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 OR fax 937-847-2350.

**POCKET TESTBENCH,** tiny, portable, RS-232 instrument. Scope, logic, counter, generator modes. Oricom Technologies, 303-449-6428 [www.sni.net/~oricom](http://www.sni.net/~oricom)

**TEST EQUIPMENT** for sale/wanted: RF, Microwave, video and fiber optic. Cable TV, Broadcast TV, satellite and related industries. Wavetek, Tektronix, Hewlett Packard and other manufacturers. Spectrum analyzers, signal level meters, sweep systems, TDRs, OTDRs, and much more. PTL Test Equipment, Inc. Phone 561-747-3647 FAX 561-575-4635.

**WAVETEK 5080.1** 3 decade step attenuators, 0-81 dB 50 ohms, DC 1GHz .1dB steps, \$150 ea.; HP 8170A pulse gen., \$1,000; HP 8165A programmable function gen., 10MHz-50MHz, \$850; Tektronix 2230 100MHz digital storage scope, \$1,200; Tektronix 2235 100MHz scope, \$600; Bafco 916AXH, sweep audio ana., \$400; HP 3586C selective level meter, \$1,000; HP 3586B selective level meter, \$800; Krohn-Hite 3323 dual variable tunable filter, 10Hz-100KHz, variable band pass, low pass, high pass, band reject, \$500; HP 3400A RMS meter, \$250. A-COMM ELECTRONICS 303-341-2283, FAX 303-341-2293.

**HP 428B** current meter, \$300; HP 3310A 5MHz function gen., \$200; HP 203A, variable phase function gen., \$300; HP 8640B sig. gen., \$1,000; HP 8640B opt 02, \$1,500; HP 5335A 1.2 counter, \$1,200; HP 5334A, \$600; HP 8363B 2.3-6.5 GHz sig. gen., \$1,500; HP 3581C selective level meter, \$800; HP 5423A structural dynamics analyzer, \$1,500; HP 8901A modulation ana., \$1,000; HP 3312A, sweeping function gen., \$500; HP 4944A TMS, \$300; HP 334A, distortion ana., \$500. A-COMM ELECTRONICS 303-341-2283, FAX 303-341-2293.

**LOGIC ANALYZER, TEKTRONIX PRISM 3002C/P.** Like new condition. 2GHz timing, 300MHz synchronous acquisition, in a 2-slot system. Contains 2 30HSM High-Speed Modules, 4 P6487 10-bit pods, 4 2GHz pods, manual, carrying case. Includes built-in LCD monitor, keyboard, hard drive, and 3.5" floppy. New price was \$20,600, asking \$2,995. 303-533-7355.

**ELECTROMAGNETIC/X-RAY** radiation meters & probes: Ailtech NM-25T \$50; International Light IL-730A \$60; MDH Corp. 2025 set, \$70; Narda 8310, 8611 \$30; 8616 \$45; 8621B, 8623B \$35; 8631, 8633, 8652, 8662B \$30; 8696 \$35; 8716 \$50; 8722 \$35. G&G 210-674-8771, fax 210-674-8775.



### lity Bitty Phone \$29.95

Did you ever wish for an incredibly small hands-free telephone that keeps your computer desk clear. Gateway's Got It! This little touch-tone phone can sit on your desk, counter top, or even be stuck to your computer monitor! Measuring only about 61mm x 48mm, it is even small enough to fit in your pocket! The detachable earset features a single earbud and a mini boom mic for lightweight hands-free operation. Handy redial and flash buttons too! Mini phone includes detachable ear piece/boom mic, modular phone cord, plastic hang tab, and instructions.



### NO TAN LINES!!! AMAZING MINI MICRO FM RADIO! \$7.50

Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, studyhall, and workouts. Battery and nugget style earphones included. Perfect for listening on the beach...compact to fit easily on even the skimpiest swimsuit, and no bulky headset means no tan lines around your ears!



### Solar Panel 12v 100mA \$19.95

Perfect for charging batteries, powering projects, light-duty emergency back-up, and other solar fun applications. These panels are framed and feature red and black alligator clip leads for easy attachment of most applications. approximate dimensions: 5.5" x 12.25" x 0.75"



### LIGHTED HEADSET MAGNIFIER \$34.95

You asked for it!!! Now we have our popular lighted headset magnifier with 4 changeable magnifying lenses! This is a HANDS-FREE way to see little tiny parts as you work on them without having to be a contortion artist with a soldering iron! The headband style magnifier features a semi-adjustable center light (4 AAA batteries not included) so you can add a little light to the area without clutching a flashlight under your chin! The adjustable headband fits comfortably around your head, and the "goggles" pull down over your eyes for easy visibility. Featuring 1.2X, 1.8X, 2.5X, and 3.5X magnifying lenses plus a flip-down magnifier lens slot allowing you to load two lenses into the headset for added magnification. (ONE REMAINS IN PLACE, THE OTHER CAN BE flipped up or down as needed.)

THE FINE PRINT: PRICES SUBJECT TO CHANGE WITHOUT NOTICE \* GATEWAY IS NOT RESPONSIBLE FOR PRINTING ERRORS \* MASTERCARD, VISA AND DISCOVER ACCEPTED \* YES, WE'LL TAKE YOUR CHECK - SORRY, NO C.O.D.'s \* \$10 MERCHANDISE MINIMUM ON MAIL ORDERS \* SUPPLY OF SOME ITEMS IS LIMITED \* PRICES DO NOT INCLUDE SHIPPING \* UPS GROUND SHIPPING/HANDLING WITHIN THE CONTINENTAL U.S. (ITEMS REQUIRING ADDITIONAL AMOUNTS ARE NOTED)...\$5.00 FOR THE FIRST ITEM, \$0.50 FOR EACH ADDITIONAL ITEM. RESTOCKING CHARGE MAY BE ASSESSED ON RETURNED ITEMS. \* WHATEVER HAPPENED TO PREPARATIONS A THROUGH G?

[www.gatewayelex.com](http://www.gatewayelex.com)

8123 PAGE BLVD \* ST. LOUIS, MO 63130 \* (314)427-6116  
9222 CHESAPEAKE DR. \* SAN DIEGO, CA 92123 \* (619)279-6802  
2525 FEDERAL BLVD. \* DENVER, CO 80211 \* (303)458-5444  
MAIL ORDERS CALL TOLL-FREE 1-800-669-5810  
FAX ORDERS (314)427-3147





**TEST EQUIPMENT:** Scopes: Tek 485 350MHz with factory service manual \$500; Leader LBO-516 100MHz \$450; Leader LBO-515B 100MHz \$400; Philips PM 3320 200MHz digital storage scope \$500; Philips PM 3217 50MHz \$225; B&K 1570 100MHz \$400; Sencore SC61 100MHz \$650; Vector scopes: Leader 5850C \$500; 5850 \$350; AC power control: Sencore PR57 (have 10) \$250. Video analyzer: Sencore VA62 with NT64 & VC63 \$800. Computer monitor analyzer: Sencore CM 2125 \$1,900; CM 2000 \$1,400; camera video analyzer: Sencore CVA 94 \$900. All equipment excellent condition. 623-561-0400, fax 623-561-2225.

**AS NEW Oscilloscopes:** Tektronix 2440 500MS/s 300MHz digital scope \$3,000; 2445B, 150MHz \$1,000; 7104 1GHz \$1,200; 2235 100MHz \$425; 30 HSN W/Doc 2GHz high speed analyzer new in factory box \$300. All with money back warranty. Psitech Plus 707-745-4804, www.psitech-plus.com

**HEWLETT PACKARD** spectrum analyzer 141T, 8552B, 8554A 1.4GHz RF section \$875; 5517B laser head accepting offers; Fluke, as new 1921A true RMS voltmeter \$300; Philips PM 6654 high resolution programmable timer counter \$200; Wavetek 3001 signal generator \$300. Psitech Plus 707-745-4804, www.psitech-plus.com

## SECURITY

**ALARM PANELS,** motion detectors, contacts, CCTV, and more. Equipment that only the professionals can buy. Visit [www.heselectronics.com](http://www.heselectronics.com) or E-Mail [alarms@heselectronics.com](mailto:alarms@heselectronics.com)

**SURVEILLANCE-COUNTERSURVEILLANCE:** I buy and sell used equipment. Steve 410-879-4035.



**CONVERTS PC MONITOR to SECURITY MONITOR.** The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size, 4-1/2" x 2-1/2" x 3/4". Over 600 lines of resolution, twice that of standard TV monitor! High quality audio output feeds speakers directly. Excellent grey-scale conversion; works well with B/W inputs. Power supply included; \$69 each. Dealers welcome. MATCO, Inc., 1-800-719-9605; Fax 847-619-0852; E-Mail: [sales@mat-co.com](mailto:sales@mat-co.com) Website: [www.mat-co.com](http://www.mat-co.com)

**QUAD MULTIPLEXER BLOW-OUT.** JUST IN big load of color + B/W quads from American Dynamic+ Robot. AD-1473 real-time B/W quad reg. \$400, NOW \$100. AD-1474 4 cam B/W multiplexer \$150. AD-1480SL16 16 cam B/W multiplexer reg. \$600, NOW \$250. AD-1584SL16 16 cam COLOR multiplexer call for price. Robot video telephone transmitters 50-80% OFF. Robot quads + multiplexers 50-75% OFF. Burle waterproof metal camera housings reg. \$85, NOW \$25. Burle steel high security inside corner housings reg. \$250, NOW \$50. Burle auto-iris lenses TC-9908 8mm 1.2 reg \$70, NOW \$40. Burle 12 mm 1.4 auto-iris reg \$75, NOW \$40. TONS of Panasonic auto-iris lenses NEW=USED. Pan + tilts, receiver drivers, fiber optic equipment. WE'LL BEAT ANY PRICE! "I must be outta my mind." PRO-VID SYSTEMS Co., Woburn, MA, 781-933-0827. E-Mail: [RicksVideo@Media1.NET](mailto:RicksVideo@Media1.NET)



## 100 WATT P A AMP

GROMMES-PRECISION ST100E AUDIO AMPLIFIER, solid state 100 watt public address amp; response 35 to 20000 Hz 4 ohm output, 0.3% distortion. Volume controls for MIC-1 & -2, AUX input, MUSIC and MASTER plus BASS and TREBLE controls. Also slide switches: Loudness and Lo Filter plus Peak Power/Over-load indicator. Back page, two Lo or Hi Z mic select, uses discrete transistors, and two XLR 3-pin male mic connections, with instructions and schematic. 4.3x15x12.8, 25 lbs sh. NEW, \$199.50

## 1950's CAR TESTER

HEYER MODEL 337 TACH / VOLTMETER with 4.5" chrome-rimmed meter. ranges 0-1000 & 0-5000 RPM and +/- 0-18 VDC, Amplifier button plus socket for timing light. With tubes 0A2 & 2D21; 6 or 12 VDC use. Nice addition to a car collector's display! 13x5x5, 9 lbs sh. UNUSED, not tested, \$24.95



## 1 to 1400 MHz Sweeper

WAVETEK 2001A SWEEP GENERATOR, covers 1 to 1400 MHz sweep and CW in bands 1-500, 450-950, and 950-1400 MHz. Sweep width 50 KHz to 500 MHz. Sweep time: 100 to 0.01 S in 4 decade steps. Markers at 0.2, 1.5 and 20 MHz harmonics and single frequencies 63 MHz, +/-0.35 and +/-0.9 MHz. Marker width 15-400 KHz in 4 steps. RF output continuously adjustable +9 to -81 dBm into 50 ohms. Requires 115/230 VAC 50-60 Hz; 5.3x 11x14.2, 25 lbs sh. USED-reparable w/book, \$395.00

## 30 FT ANTENNA MAST

AB-1244/GRC MAST KIT, twelve aluminum alloy on steel sections form sturdy, yet lightweight 30 foot 1.7" dia mast. Kit includes five each lower and upper sections, one ea lower and upper adapter sections, gin pole swivel base, four ea 36 and 42 ft guy ropes, four guy stakes, two guy rings plus a 2.5 pound sledge hammer. Part of OE-254/GRC antenna set; 30 lbs. NEW, \$139.50

Prices F.O.B. Lima, Ohio. VISA, MASTERCARD accepted. Allow for shipping charges. Write for latest Catalog.

Address Dept. NV + Phone 419/227-6573 + FAX 419/227-1313

E-mail: [fairradio@wcoil.com](mailto:fairradio@wcoil.com) Home Page: <http://www2.wcoil.com/~fairradio>

## FAIR RADIO SALES CO.

1016 E. Eureka + Box 1105 + Lima, Ohio 45802

Write in 71 on Reader Service Card.

## MICRO VIDEO CAMERAS



MB-650PA - \$139.95  
2.8mm Pinhole Lens.



MB-650UA - \$129.95  
4.3mm Micro. Lens

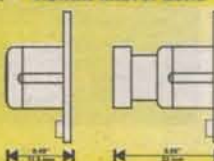


MB-750P - \$129.95  
2.8mm Pinhole Lens.

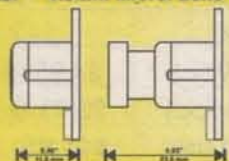


MB-750U - \$119.95  
4.3mm Micro. Lens

MB-650a Series  
• Built-In Audio  
• 1.18" sq.  
• 380 TV Line



MB-750 Series  
• 1.25" sq.  
• 420 TV Line



The Best, Smallest, Micro Cameras on the Market Today!  
Call and Compare! We Match or Beat All Prices!

## Panasonic Color Camera Sale



MB-45cB - \$99.95

Size: 1.25 x 1.25 sq. w/ Footprint

### Micro Color MB-45cB: \$99.95

- Wide Voltage Range, 5-14 Volts!
- Small Footprint!
- Self contained ultra small package design for various applications.
- MCM PCB design for minimizing the size and improve durability.

### Specifications: MB-45cB Color Camera

Pick-up device	1/4" Interline transfer
Effective Pixels	512 (H) x 496 (V)
Scanning System	2:1 Interlace
	525 lines - 60 fields
Frame per second	30 frames
Synchronization	Internal
Video output	VBS. 1vpp 75 Ohms
Horizontal Res.	More than 330 lines
AGC	On fixed
White Balance	ATW fixed
Operating Temperature	32°F to 104°F
Ambient conditions	Indoors
Lens	F2.8 Hor. Angle 45° - Ver. Angle 34°

## WIRELESS VIDEO



Compatible with AC or Battery

Wireless 4-Channel B/W & COLOR Cameras Available!

Wireless Observation System's  
GFS-1001 (900MHz) - \$499.95  
GFS-1001c (900MHz) - \$599.95  
(900, 1.2 & 2.4 Ghz systems available.)

GFT-1001 \$189.95  
Gives any camera the ability to be Wireless.



Transmits Over 1000 ft.

## Our Smallest Video Camera



CMOS Camera  
CM-550u - \$69.95

PinHole Camera:  
CM-550p - \$69.95



## LIPSTICK CAMERAS

These cameras are supplied with a PCM-1 Video/Power cable. The BNC connection is for standard video connection to a Monitor or VCR.

LP-850p  
\$139.95



Length: 1.37"  
Diameter: .87"

LP-850i  
\$129.95



Length: 1.9"  
Diameter: .91"

1-800-752-3571

Visit Polaris Ind. Web Site at:  
<http://www.polarisusa.com>

Polaris Industries 470 Armour Drive NE • Atlanta GA 30324 • Tech Info: 404-872-0722 • FAX 404-872-1038

Write in 70 on Reader Service Card.

Prices, availability and specifications are subject to change without notice. Shipping and Handling are not included with price.

Nuts & Volts Magazine/JUNE 1999 43





**SPECIAL! IC 113:** PIR motion detector with audio! W/ NO/NC alarm output. CCD camera with audio can be turned on by detector. 5-1/4" (L) x 2-3/4" (W) x 2" (D). \$89 @ 5 pcs., \$82 @ 10 pcs. Matco, Inc. 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com



**NEW! AS-1004,** 2.4GHz transmitter & receiver with audio! Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 400 TV line. \$189 a pair @ 5 pcs., \$179 @ 10 pcs. Additional camera \$119 @ 10 pcs. Matco, Inc. 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com



**NEW PRICING! QVS 104:** Quad video system. Near real-time. 8.5" (W) x 2" (H) x 5.5" (L). \$149 @ 5 pcs., \$145 @ 10 pcs. Also available: 8-2 video auto-switcher, \$65 @ 5 pcs., \$59 @ 10 pcs. Distributors welcome. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com



**COUNTER-SURVEILLANCE=\$250 HR!** Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **\$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: 1-800-732-5000.

**8 CAMERA DUO-QUAD DISPLAY BLOW-OUT.** 8 camera B+W 2 page hires. real-time quad w/2 video outputs. Selectable display quad/sequencer or both. These units are brand new discontinued American Dynamics AD1475A. Similar units in this magazine are twice the price. Not a China imitation. Industrial unit. Our reg. price \$350, **NOW \$175 EA.** While they last! Pro-Vid Sys. 781-933-0827. E-Mail: RicksVideo@MSN.COM

## Tired of Expensive Inkjet Cartridges ? Save 90% on Inkjet Inks !

Printer	# of Refills		Cost/Refill		Kit Price	
	Black	Color	Black	Color	Black	Color
HP 500 Series, 400, Officejet 300, 350, Fax	7	14	4.71	2.85	32.95	39.95
HP 600 Series, Officejet 500, 570, 600	7	14	4.71	3.21	32.95	44.95
HP 820C, 855C, 870C, 1000C, 1150C, Copier 120, 210	6	10	6.67	4.00	39.95	39.95
HP 720C, 722C, 712C, 880C, 890C, 895C 1120C, 1170C	6	10	6.67	4.50	39.95	44.95
Canon BJ-10, 200, 210, 240, 250 Apple SWriter 1200, 1500	14	20	2.15	2.00	29.95	39.95
Canon BJC-4000 Series, C2500, C3000, C3500, C5000	60	60	0.50	0.67	29.95	39.95
Apple StyleWriter 2400, 2500						
Canon BJC-600, 610, 620 Apple SWriter Pro	20	13	1.50	3.07	29.95	39.95
Epson Stylus Color, Color Pro, Pro XL	12	12	2.50	3.33	29.95	39.95
Epson Stylus Color II, IIs, 1500 (Black)	15	15	2.00	2.66	29.95	39.95
Epson Stylus Color 500, 200	20	17	1.50	2.35	29.95	39.95
Epson Stylus Color 400, 600, 800, 850, Photo	20	17	1.50	2.65	29.95	44.95
Lexmark JP 1000, 1020, 1100, ExecJet II, IIC, Medley 4C	10	17	3.00	2.35	29.95	39.95
Lexmark JetPrinter 5700, 5000, 7000, 7200, 3200	15	17	2.67	2.35	39.95	39.95
Compaq IJ700, IJ900, Xerox XJ9C	15	17	2.67	2.35	39.95	39.95
Xerox Home Center 450C, XJ6C Inkjet	22	12	1.36	3.33	29.95	39.95

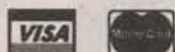
## SAVE 30 - 50% on New Compatible Cartridges!

Printer	BLACK CARTRIDGE	COLOR CARTRIDGE
Canon BJC-4000 Series, C2500, C3000, C3500, C5000	\$5.50	\$12.95
Apple StyleWriter 2400, 2500	\$5.50	\$12.95
Canon BJC-600, 610, 620 Apple StyleWriter Pro	\$4.95 (9cc)	\$4.95 @ (9cc)
Hi-Capacity Canon BJC-600, 610, 620	\$5.95 (15cc)	\$5.95 @ (12cc)
Canon BJC-70, BJC-80	\$9.95 (3-pak)	\$14.95 (3-pak)
Epson Stylus Color, Color Pro, Pro XL	\$12.00	\$19.00
Epson Stylus Color II, IIs	\$14.00	\$19.00
Epson Stylus Color 500, 200	\$14.00	\$19.00
Epson Stylus Color 400, 600, 800, 850, 1520, Photo	\$14.00	\$19.00
Epson Stylus Color 440, 640, 740	\$14.00	\$19.00

- BULK Inks, Refill Accessories
- Glossy card stock & Coated Paper
- School & Government PO's Welcome
- 2 - 3 Day Shipping

**Inkjet**

**Southwest**



**Quality Inks for:**  
HP • Epson • Lexmark  
Canon • Apple • DEC

**Call or see us online!**

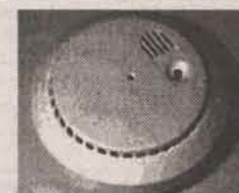
Monday - Friday  
8:30 - 5:30 PST 11:30 - 8:30 EST

**www.inkjetsw.com**

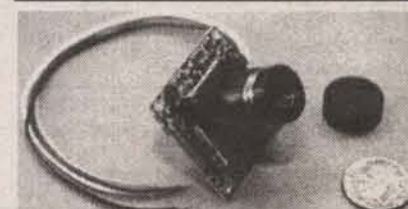
(480) 668-1069 Fax

**1-800-447-3469**

(480) 668-0959



**SALE! PS 102:** Built-in pin hole CCD, lens size: 3.6mm. 5-1/2" (D) x 1.7" (H). \$79 @ 5 pcs., \$72 @ 10 pcs. Distributors welcome. Matco, Inc., 1-800-719-9605 Fax: 630-350-9546. E-Mail: nsales@mat-co.com Web site www.mat-co.com



**B/W 430 LINE CCD CAMERA** with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; 9-14 VDC, 0.08 lux, IR sensitive; 1.27" x 1.27" x 0.5" D pinhole or 1" deep standard. Price @ 10 pcs., \$44 each. Enclosure: \$8; optional lens: \$18. Dealers welcome. MATCO, Inc. 1-800-719-9605. Fax 847-619-0852. E-Mail: sales@mat-co.com Website: www.mat-co.com

## SATELLITE EQUIPMENT



**BEST PRICING** on 18" satellite TV systems for home and RV. DSS, DISH Network programming, multi-room viewing options, accessories. www.skyvision.com Call 1-800-543-3025.

**1999 DSS SOFTWARE COOKBOOK** 700+ CD-ROM COLLECTION: CLONING, REVERSE-ENGINEERING, PPV, ADULT, EMULATORS, DIAGRAMS, SCHEMATICS, PATCHES, PLANS, MUCH MORE. (SPECIAL: 1ST 700 ORDERS GET 700+ ADDITIONAL PROGRAMS!) WHOLESALE ONLY \$22 (BUY 2, GET 1 FREE!!!). DSS TEST-CARD INFO SOURCE MANUAL \$10. VISA/MC/AMEX/COD/CHECKS/MO. BRINKER ENGINEERING LABS, USA. CALL NOW 352-429-5496.

**DSS TEST CARD** information. Call toll free, 1-888-416-7296.





**FREE BIG dish catalog.** Low prices! Systems, upgrades, parts, and "4DTV." Skyvision, 1010 Frontier Dr., Fergus Falls, MN 56537. [www.skyvision.com](http://www.skyvision.com) Call 1-800-543-3025.

**FREE FLYER** on DBS files, hacking, hardware info. Bill 1-800-879-9657.

**THE BEST** is back to stay. Master code recovery. 16c5x, 16c62x, PALS, GALS, other microcontrollers, etc. Check out our web page at [www.acdinc.com](http://www.acdinc.com) for details or call 703-764-5361 or write Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway, Suite 317, Burke, VA 22015.

**DEALERS WANTED:** Sell Digital Satellite Systems to receive free ethnic programming. Excellent profit margin <http://www.dmsiusa.com> 1-888-591-4416.

## MILITARY SURPLUS ELECTRONICS

**MILITARY FLUORESCENT** lamp power reducers. Reduce any 40 watt lamp's power use by 50%, \$6 each ppd. E.P., 41-11 150th St., Flushing, NY 11355.

**WANTED:** ARC-5 & SCR-274N receivers and manuals. John Broussard, 312 Guilbeau, Breau Bridge, LA 70517.

## AUDIO - VIDEO - LASERS



**ANTIQUE VIDEO TRANSFER SERVICE:** transfer of any 2" quadruplex video tapes. Quad TV spots, features, medical, corporate, military, government, and university tape libraries TRANSFERRED TO VHS. Affordable. Phone/fax 415-821-7500. If no answer call 415-821-3359 or pager 415-245-8700.



**CONVERTS PC MONITOR to SECURITY MONITOR.** The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size, 4-1/2" x 2-1/2" x 3/4". Over 600 lines of resolution, twice that of standard TV monitor! High quality audio output feeds speakers directly. Excellent grey-scale conversion; works well with B/W inputs. Power supply included; \$69 each. Dealers welcome. MATCO, Inc., 1-800-719-9605; Fax 847-619-0852; E-Mail: [sales@mat-co.com](mailto:sales@mat-co.com) Website: [www.mat-co.com](http://www.mat-co.com)

**STEALTH MOD** chips for Sony PlayStation. Now even your anti-mod games will work. Only \$9.95 ea. + \$3.35 shipping. Call Toll Free 1-888-467-6150. All credit cards accepted. [www.computerconnectionusa.com](http://www.computerconnectionusa.com)



**SYNC-A-LINKS's 3-D Scopers™** digital color CCD cameras for stereoscopic imagery. At a reasonable cost. Phone or Fax 918-479-6451 or write to Sync-A-Link, PO Box 4, Locust Grove, OK 74352.

**FREE LASER CATALOG.** Helium-Neon, Argon, ruby, visible laser diode modules, lightshows, holography, laser pointers. Lowest prices. Midwest Laser Products, PO Box 262, Frankfort, IL 60423. 815-464-0085 [www.midwest-laser.com](http://www.midwest-laser.com)

**WANTED: PRO** video equipment, VCRs, switchers, cameras, etc. Advanced Media 702-874-1911.

**GAME WIZARD** cartridge for PlayStation. Works like a mod chip and the best cheat cartridge all in one. It will use all the same cheat codes the others use. Only \$29.95 free shipping. Toll Free 1-888-467-6150 all credit cards accepted. [www.computerconnectionusa.com](http://www.computerconnectionusa.com)

**ATV 2.2GHz to 2.7GHz** wireless video data link module tuner & transmitter 100mW. Picotronic, web: <http://members.aol.com/picotronic/atv.htm>

**SONY PLAYSTATION MODCHIPS.** Allows playing of CDR backups & imports. \$10 + \$3 shipping. 619-590-9320.

**VIDEO PROJECTORS,** GE Tularin up to 2,000 watt. Projects to 20' wide screen, will accept smaller lamps. With spare parts and lens. \$5,000 ea. or best. 3 available. 760-736-4411.

**BROADCAST VIDEO** equipment wanted: all types, new or old. Please call, Jon with info. 1-800-539-2859.

# RAINBOW KITS

**FAN CONTROLLER**  
Use this kit to control cooling fans, or any device that is temperature activated. Output is 100mA. For a 3 Amp application use the Relay kit RP-1 or the new Micro-controlled. Operating voltage: 7.5 to 18V DC. Size: 1.5" x 1.2" (Temperature Range 32° - 200° F)  
FC-1 KIT \$14.95

**FLASHING SAFETY LIGHT**  
• Push ON / Push OFF switch.  
• Flashes 3 weeks on 2 AAA batteries.  
• Great for kids, bike riders and joggers.  
• Keep in car for emergencies.  
• Tough ABS case with belt clip.  
• Size: 1 3/8" x 2 1/4" x 1 1/8"  
BFL-3 BUILT \$6.95 2 for \$9.95

**WIDE BAND PRE-AMP** Uses PCB and surface mount technology for better performance. Use this for scanners, HT's, Frequency counters, Satellite Receivers. It amplifies low-level (weak) signals. If the signal is extremely low, two amplifiers can be used in a series.  
• 1MHz to 2.5 GHz 2.8dB NF  
• 1dB compression-OdBm  
• Gain: 1MHz-20dB to 2.5GHz-6dB  
• Power requirement: 12v @ 6Ma  
WBA-6 KIT \$19.95

**TV NOTCH FILTERS** FOR CHANNELS 2 thru 22 ONLY  
Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a BEEP BEEP BEEP. Works on cable channels (2 thru 22) only.  
NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.  
DF-222 KIT \$14.95

**FM STEREO TRANSMITTER** Have your own FM radio station. Any stereo signal you plug into the FMST-100 transmitter kit will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Plug in your CD player, tape deck and have a wireless link to any FM radio, within 200 ft. Listen to your CD while mowing the lawn. Transmit from your car to your camper, or through an auditorium. Transmit music on one channel sing on the other. Compatible with any audio system. Clarity is excellent, approx. 40dB stereo separation. Length of antenna determines distance of transmission. Comes complete with left & right input level control as well as a crystal for left & right stereo separation. ANTENNA NOT INCLUDED 9v Battery operation.  
FMST-100 Cabinet SIZE: 1.5" x 1.6" KIT \$29.95  
SIZE: 1.5" x 2.5" x 3" \$8.95

**KEY CHAIN LASER PEN**  
Comes with 4 extra heads  
• Smiley face • I Love You • Hearts • Skull (all different) 2 1/2" Long 4mm/650 nm  
LP-4 BUILT \$12.95

**AT THIS PRICE THEY WON'T LAST LONG!**

**NEW**

**EXTRA BATTERIES \$2.95**

**SHOWN ACTUAL SIZE**

**LED's don't burn out!**  
• Battery lasts for years!  
• If you have your keys, you'll have a flashlight.  
• Replaceable battery!  
• Better buy 2, your wife is going to take yours!

**Red MLR \$9.95 each**  
**Yellow MLY \$9.95 each**  
**Blue MLB \$12.95 each**  
**White MLW \$12.95 each**  
**Infrared MLJ \$12.95 each**

**LIE DETECTOR**  
This kit can be great fun at parties. When you lie, generally your hands will sweat and the more you sweat the louder the tone. This kit allows you to measure these changes, only a slight amount of change will cause the tone to increase in frequency. Power requirement 6 to 12v DC. SIZE: 8" x 1.2"  
LD-1 KIT \$9.95

**BUSY PHONE LIGHT**  
Add this little kit to any or all of your telephones. When one phone is used a red LED will light on the other extension. This lets everyone know when your computer modem is in use. Power requirement 9v DC. SIZE: 1.1" x 6"  
TEL-LITE KIT \$9.95

This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.  
**KIT BOOK \$14.95**

**SUPER SNOOPER BIG EAR**  
Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12v DC. SIZE: 1.75" x 1"  
AA-1 BUILT \$29.95 KIT \$10.95

**STROBE LIGHT**  
Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC. Size 3.5" x 1.9"  
ST-1 KIT \$11.95

**AUDIO PREAMP**  
Boost your microphones output up to line level! Plug your mic into our AP-1 and drive your amp. to full capacity. Connect an AP-1 to a pair of amplified speakers, plug your mic in and you have an instant PA system. Requires 6 to 12v DC. Size: 1.75" x 1"  
AP-1 KIT \$9.95

**16 TONE DECODER**  
Sweet 16 tone decoder operates great over phone lines, radios or scanners.  
• 16 TTL Level Outputs  
• DTMF Decoder Decodes 16 different touch tones using the phone, radios, or scanners.  
• One relay & driver circuit on board.  
• 9v battery powered. Size: 2 3/4" x 2 1/8"  
TT-16 KIT \$34.95

**WIRELESS FM MICROPHONE**  
Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"  
WM-2 KIT \$14.95

**DC VOLTAGE MONITOR**  
If battery status is important, you need this kit. This kit uses 7 LEDs to monitor 12v DC in 1v, 1/2v, or 1/4v steps. Monitor 8v or 5v in 1/4v steps. Great for boats, motor homes, model planes or race car ni-cads. All parts and instructions are included. SIZE: 1.3" x 2.7". If you want to switch more power see our Triac (TP-1).  
VM-1 KIT \$7.95 For 110 AC VM110 KIT \$10.95

**INDUCTANCE METER**  
This is the kit everyone has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Power requirement 9v DC. SIZE: 1.75" x 2.5"  
IA-1 KIT \$14.95  
IA-1 CABINET \$8.95

**DIGITAL THERMOMETER**  
The DT-3 kit will turn your digital volt ohm meter into an accurate digital thermometer with .1 degree resolution. Measure temperatures from -40° to 250° F. The remote sensor is .25" sq. and can be mounted many feet from the meter. Power requirement 9v DC. SIZE: 2" x 1.35"  
DT-3 KIT \$8.95

**CAPACITANCE METER**  
This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measure capacitors from <2.2pF to 2.2uF. Power requirement 9v DC. SIZE: 1.80" x 2"  
CA-1 KIT \$12.95

**VOICE ACTIVATED SWITCH**  
This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm. The VOX-1 kit has 100mA of output that operates a relay, light, motor, ? What could you do with a sound activated switch? Power requirement 7.5 to 18v DC. SIZE: 1.5" x 1.3"  
If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.  
VOX-1 KIT \$6.95

**PHONE RECORDING SWITCH**  
This phone line powered switch is small enough to be installed anywhere. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use it in your office to record all phone calls so you don't lose important information. SIZE: 1" x .6"  
If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.  
TEL-SW1 KIT \$12.95

**WATER ALARM**  
Don't ever get stuck with a flooded basement or over fill your water bucket. When the liquid level reaches the sensor it automatically turns the pump on or off. The Water Alarm supplies you with 100 mA of output that activates a relay (that you supply). This relay can turn on a sump pump, or in applications where you are filling a area with liquid it turns off the pump. Sensor included. Size 1.4" x 2"  
WA-2 KIT \$17.95

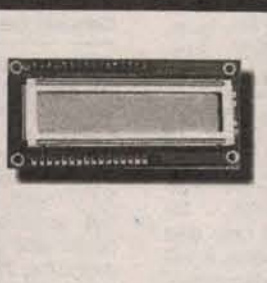


## LOWEST COST LCD'S ON EARTH



### VIDEO LCD

4 Inch Video NTSC \$150  
Sharp P/N 4LU4E  
Composite NTSC & RGB Input  
12:00 OR 6:00 Viewing Angle  
Integrated Backlight & Inverter  
Extended Temp: -10 to +60 C  
Brightness: 260 nits  
Power Consumption: 4.3 Watts  
Contrast: 50 to 1



### CHARACTER LCD

OPTREX DMF-5005N-EW  
240 x 64 Graphic EL Backlit STN \$30  
OPTREX DMF-5005N  
240 x 64 Graphic Reflective STN \$30  
SANYO DM2023-7G1  
2 x 20 Character Reflective STN \$8  
SHARP LM20A21  
2 x 20 Character Reflective STN \$8  
VIKAY 2035TNLD NOTW-D  
2 X 16 Character LED Backlit STN \$8



### LCD MONITOR

10.4" DSTN or 12.1" TFT  
Analog SVGA Input  
Autosync  
Auto Sizing  
Automatic Expansion of VGA  
images to SVGA (On 12.1")  
Very Aggressive Pricing  
Starting under \$500!



### TOUCH MONITOR

EarthVue 10.4  
10.4" VGA TFT  
Analog VGA Input  
105 Nit Brightness  
RS-232 Touch Screen Option  
Only 9.9"W x 7.7"H x 1.5"D  
Ideal For Factory Automation  
Fully Articulating Ball Mount  
Only \$1095 With Touch



### LCD DISPLAYS

6.3" Mono STN \$60  
9.4" Mono Reflective \$60  
8.4" TFT \$250  
9.4" DSTN \$150  
10.4" TFT \$350  
10.4" DSTN \$240

NoteBook Screens  
340 Models in Stock  
Obsolete Screens Stocked  
Hard To Find LCD? Call!



### CONTROLLERS

ISA  
PCI  
PC/104  
NTSC  
Analog VGA  
Complete LCD Kits with LCD,  
Controller & Cable Starting  
under \$200



## EARTH

Computer Technologies

"The World Leader In LCD Recycling"

Ph: (949) 361-2333 Fax: (949) 361-2121

<http://www.flat-panel.com>

Write in 74 on Reader Service Card.

## Network Service Tool Set

Popular installation and service tools for networks, modems and telephones. All hand tools are professional heavy duty type.

Use the compact tester on 10BASE-T (UTP & STP), thin Ethernet (BNC), 8-position Token Ring, AT&T 258A and EIA/TIA 568A/B. Automatically scans cables for continuity, wiring sequence and polarization. Tests STP cable ground. Testing installed cables is easy with Remote Terminator and gender changers (UTP and BNC). 9V battery included.

- Coax Stripping Tool, RG-58 & RG-59
- BNC Crimping Tool, RG-58 & RG-59
- Modular Cutting/Stripping/Crimping Tool (4, 6 & 8-Position)
- Multi-Network Cable Tester
- AC Receptacle Tester
- Cable Cutter

Order No. 55625 \$197.00



## PC Service Tool Set

Contains all tools needed to troubleshoot & service IBM-compatible PCs. Set includes:

- AMI Diagnostic Software
- POST Card
- Logic Probe
- Digital Multi-Meter
- AC Receptacle Tester
- Serial Adapter
- Serial & Parallel Loopback Connectors
- DIP IC Puller
- PLCC IC Puller
- Grounding Wrist Strap
- Key Top Puller

Order No. 55000 \$198.00



CALL TODAY!

800-854-7393



Write in 76 on Reader Service Card.

## EZ-EP DEVICE PROGRAMMER - \$169.95

Check Web!! -- [www.m2l.com](http://www.m2l.com)

**Fast** - Programs 27C010 in 23 seconds

**Portable** - Connects to PC Parallel Port

**Versatile** - Programs 2716-080 plus EE and flash (28, 29) to 32 pins

**Inexpensive** - Best for less than \$200

• Correct implementation of manufacturer specified algorithms for fast, reliable programming.

• Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web.

• Full over current detection on all device power supplies protects against bad chips and reverse insertion.

• Broad support for additional devices using adapters listed below.

### Available Adapters

EP-PIC (16C5x, 61, 82x, 71, 84) \$49.95  
EP-PIC84 (16C62-5, 72-4) \$39.95  
EP-PIC12 (12C50x) \$39.95  
EP-PIC17 (17C4x) \$49.95  
EP-S1 (8751, C51) \$39.95  
EP-11E (88HC11 E/A) \$59.95  
EP-11D (88HC11D3) \$39.95  
EP-16 (16bit EPROMs) \$49.95  
EP-28 (286E02, 3, 4, 8, 7, 8) \$39.95  
EP-SEE2 (93x, 24x, 25x, 85x) \$39.95  
EP-750 (87C750, 1, 2) \$59.95  
EP-PEEL (1CT22v10, 18v8) \$59.95  
EP-1051 (89C1051, 2051) \$39.95  
EP-PLCC (PLCC EPROMs) \$49.95  
EP-SOIC (SOIC EPROMs) \$49.95  
EP-TSOP (TSOP EPROMs) \$59.95  
Many Other Adapters Available

### M<sup>2</sup>L Electronics

970/259-0555

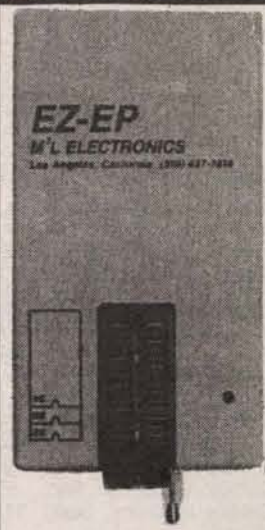
Fax: 970/259-0777

250 CR 218

Durango, CO 81301

CO orders please add 7% sales tax.

<http://www.m2l.com>



Write in 75 on Reader Service Card.

**LASER SHOW SYSTEMS AND COMPONENTS.** Hobby and professional projectors. [www.redline-lasers.com](http://www.redline-lasers.com)

**LASER POINTERS.** 645nm wavelength, 67mm x 13.5mm dia. Beam up to 500 meters. Special price @ \$14.99 + \$4 S&H. 10 for \$100 + \$10 S&H. Batteries included with 1 year limited warranty. Catalog available for two 33-cent stamps. Bulk quantity discount available. SoCal (Nevada) Inc., 403 N. Freeman St., Oceanside, CA 92054. E-Mail: phcesq@pe.net

**SYNC-A-LINK UNIVERSAL video sync generators.** For more details phone or fax 918-749-6451 or write to Sync-A-Link, PO Box 4, Locust Grove, OK 74352.

## CABLE TV

**UNMODIFIED CABLE CONVERTERS.** Zenith ST1600, ST1086, ST300, Panasonic 175, 145 vol. & non-vol. Regal RR-92 & RC 83, DP5, DP7, DRZ, 5503 VIP, SA 8580. Guaranteed low prices. Please call for more converters 405-631-1856.

**TOCOM UNMODIFIED 5503 CABLE CONVERTERS UNTOUCHED.** \$6 EACH. 10 LOT MIN. CALL 706-657-4445.

**CABLE PARTS & EVERYTHING.** Best prices & quantity discounts. WE DON'T SELL BOXES. 1-800-MODULE-0.

**CABLE CONVERTERS.** Original equipment with remote. Like new, ready to go. Lowest prices guaranteed. Limited models. Tele-Pix Electronics, 412-833-0773.

**NEW! CABLE converter electronic service equipment and supplies for most cable converter boxes.** Highest service, lowest prices. Call Ken Erny Electronics. 24 hr. order and information hot line 516-389-3536.



**NOTCH FILTERS** 110, 108.5, 106.5, 97.5 75dB deep notch. \$19.95 ea., 1-5 qty. \$15.95 ea., 6-10 qty. \$11.95 ea., 11-20 qty. \$9.95 ea., 21 or more qty. Call 24 hr. order and information hot line 516-389-3536.

**ATTENTION: YOU'VE tried the rest, now go with the best. UNICORN ELECTRONICS** where our valued customers ALWAYS come first. **CABLE CONVERTERS AND ACCESSORIES.** We will beat all competitors prices GUARANTEED. All UNITS in STOCK FOR IMMEDIATE SHIPMENT. FREE batteries and coax cable. FREE bullet protection with every unit purchased. FREE shipping with a \$500 purchase or more. NO COD charges. ALL products come with a 1 year warranty and a 30 day money back guarantee. Please give us a call TOLL FREE 1-888-738-8181 9am to 6:30pm EST. VISA, M/CARD, DISCOVER, COD. UNICORN Electronics does not advocate unauthorized use or theft of cable services.

THE BEST is back to stay. Master code recovery. 16c5x, 16c62x, PALS, GALS, other microcontrollers, etc. Check out our web page at [www.acdinc.com](http://www.acdinc.com) for details or call 703-764-5361 or write Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway, Suite 317, Burke, VA 22015.

**PLAYSTATION MOD chips.** Works with all models up to 750x. Color instructions. Seven wire hook up, does not come with wires. \$5 each, plus shipping charges. 10% discount for 10 or more. Call 703-741-0338 to place an order.

**GENUINE UNMODIFIED JERROLD DPBB7312 FOR SALE 10 LOT MIN.** CALL 708-715-6118.

Continued on page 55



If you've experimented with BASIC Stamps, you know how easy they are to use. Just plug them into a 9V battery, a PC cable, and you are off and running. However, as your projects grow, the Stamp can't always keep up. Maybe you need interrupts, or faster processing.

You might want to use onboard ADCs or DACs. At this point, most people turn to the PIC microprocessor family from Microchip.

The PIC is certainly not as easy to use as the Stamp. However, it is a lot more powerful. Depending on the type of PIC you get, you'll also

equal to 200MHz? The secret lies in how the PIC handles its internal clock. Suppose you have a 16F84 (a common PIC chip) connected to a 4MHz crystal. True, the clock speed is 4MHz, but the chip only executes most instructions every four cycles, which reduces your true clock speed to 1MHz.

The SX can operate in compatibility mode, where it also uses four clock cycles for most instructions. However, it also has a turbo mode that executes most instructions in one cycle. Combined with a 50MHz clock, this works out to be roughly equivalent to a 200MHz PIC! I say roughly because some instructions take eight real clock cycles on a PIC, but only require three cycles on the SX in turbo mode, so the actual throughput is even higher. Not satis-

The SX automatically saves and restores its own context. If this isn't enough, you can also enable an internal RC oscillator that runs up to 4MHz with no external components. Remember, in turbo mode, that's like a 16MHz PIC.

### The Virtual Peripheral Concept

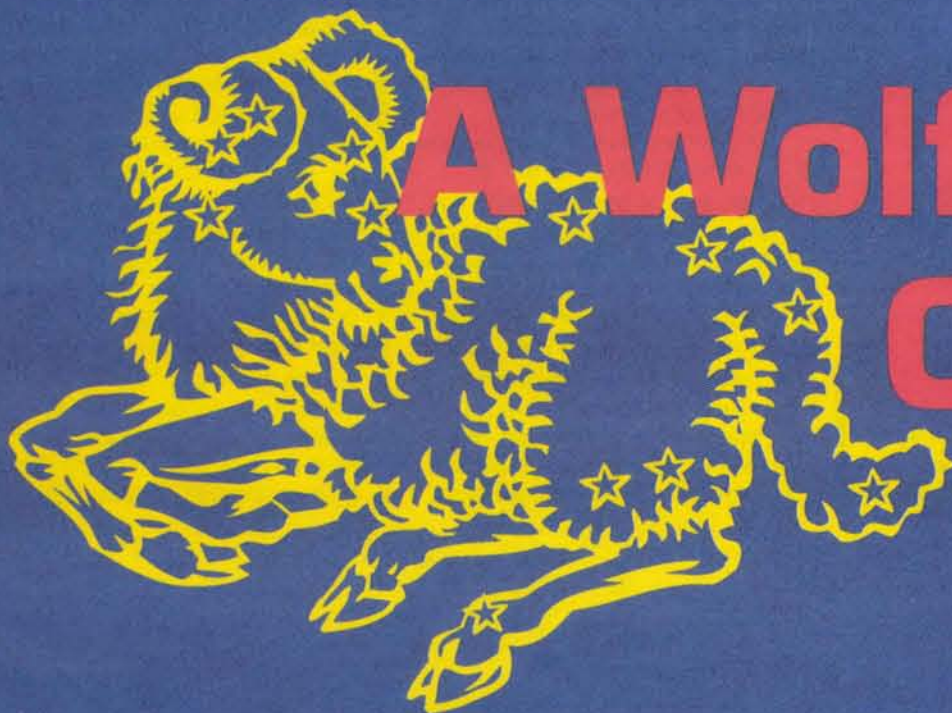
The key to Scenix's game plan is virtual peripherals (VPs). What this means is that the SX doesn't have fancy onboard I/O — no UARTs, no SPI interface, no ADCs. Instead, Scenix concentrates on making the processor ultra-fast. The only unusual I/O device on the chip is an analog comparator.

Does this mean you can't use all these I/O capabilities? Not at all.

Scenix supplies software modules that implement popular I/O devices in software (VPs). Present VPs include UARTs, ADCs, touch-tone generation and recognition, PWM output, and more.

Is this better? That depends on your point of view. Software routines mean a bit more work for you as a developer. They also take away processing time from your application. However, the flexibility is enormous. If you don't like the way a piece of hardware works, you can't easily change it. You certainly can't swap out, for example, a UART for an ADC. Changing a VP is as easy as altering the code.

As for speed concerns, the SX is fast enough to do quite a few things at once. If you were planning on using, for example, a 20MHz PIC,



# A Wolf in PIC's Clothing?

by Al Williams WD5GMR

gain access to onboard peripherals. Some PICs have onboard EEPROM, UARTs, ADCs, I2C interfaces, and other useful devices. The result is that many Stamp users eventually migrate to PICs — at least for the more taxing projects.

In this article, I'll show you a new microprocessor from a company named Scenix. Their Scenix SX chip is compatible with a PIC, but has even more features. Not to mention that it can run about as fast as a PIC with a 200MHz clock!

Interested? You can get started with the SX for very little money, and you can own the top-of-the-line development system that includes real-time debugging and emulation for just a few hundred dollars. While you examine the chip, you'll also see a PC data acquisition circuit that does analog-to-digital conversion and high-speed serial output all in software.

### When Does 50=200?

If you read the SX data sheet, you'll find that the current parts operate at 50MHz. How does this

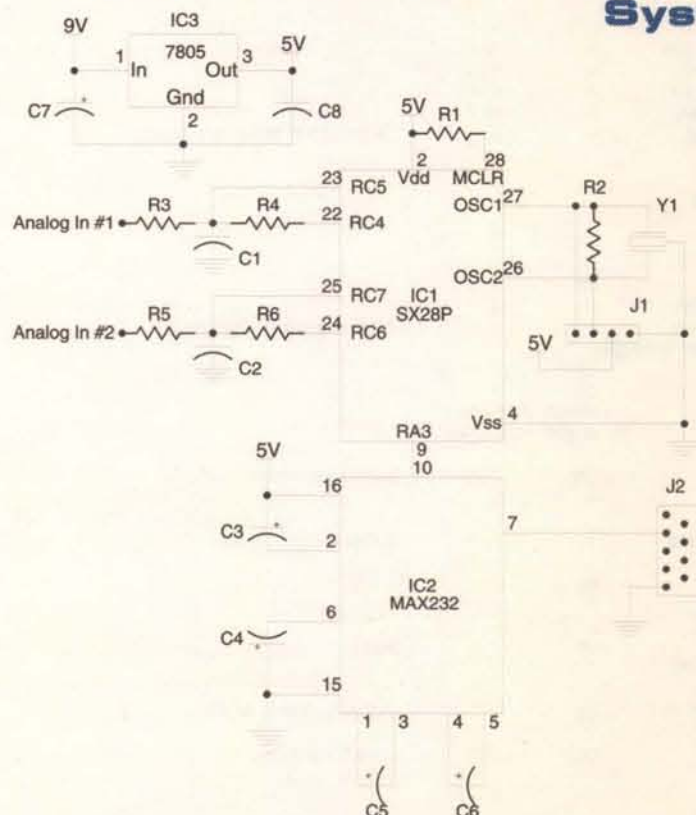
fied with 50MHz? A 100MHz device is on its way and may even be available by the time you read this.

### Differences and Similarities

The SX resembles a PIC16C5x processor. The instruction set is a superset of the 16C5x. If you are used to using the 16F84 processor, you will see there are a few slight differences since the 16F84 uses a slightly different core than the 16C5x. The SX has several new instructions, and all of the old 16C5x instructions. The chips are pin-compatible (in both 18- and 28-pin variants). Besides that, the SX has 136 bytes of RAM and 2K of program storage — more than most of the 16C5x family.

Unlike a 16C5x, however, the SX has EEPROM memory — no UV eraser required. There are new instructions that let you take advantage of new features, a larger hardware stack, and enhanced I/O capabilities. Interrupts are significantly easier to handle, too.

Figure 1. The Data Acquisition System





```

SX Key - sxdas.src
File Edit Run Help

:loop      clr      fsr          ;reset
           setb     fsr.4
           clr      ind
           ijnz     fsr,:loop

           mov      !option,#%10011111 ;enable
;
;
top        ; main loop
:wait      bank      analog
           jnb      complete.1,:wait
           mov      v0,adc0
           mov      v1,adc1
           clr      complete ; start new conv
           mov      w,#zero_offset
           mov      w,v0-w
           call     send_hex
           mov      w,#zero_offset
           mov      w,v1-w
           call     send_hex
           mov      w,#13
           call     send_byte ;send c
           jmp      top

```

**Figure 2. The SX-Key Editor**

the SX (in turbo mode) is 10 times faster so, in theory, it should be able to handle your program, plus do nine more tasks of the same complexity.

### Development Tools

One thing that makes the PIC a popular choice is that there are many cheap programmers for the

PIC. In fact, you can find plans on many web sites to build your own programmer for a few dollars. Although there aren't as many free and cheap programmers for the SX yet, they do exist (see the resource box accompanying this article). I built the fluffy programmer (which uses a PIC to program the SX) in about a half-hour from parts I had around the lab.

The official development tool is from Parallax (the company that makes BASIC Stamps). They sell several versions of the SX Key and also an inexpensive SX Blitz. The Blitz is very serviceable as a programmer, but the Key is what you really want.

The SX Key plugs into your PC serial port and programs the SX chip in circuit. It also can generate clock pulses to run the system in real time. Better still, it can debug the software in the chip at full speed. You can start and stop the target system, examine registers, and even set breakpoints. This is full-speed hardware emulation.

Of course, you can get this type of emulation for the PIC, too. It requires special bondout chips and hardware that costs between \$600.00 and \$1,500.00. The basic SX Key hardware is around \$240.00. The full-blown top-of-the-line system is around \$335.00. The only catch is that you must let the Key supply your clock, you must have the watchdog timer off, and you have to have around 138 free program instructions in the device.

### Getting Started

Just to try things out, I decided to build a simple data acquisition system with the Scenix SX. I wanted the board to read voltages on four different pins and send the results to a PC at 19.2K baud. To simplify the PC software, I wanted to avoid sending binary data. The output for each channel is two hex digits representing about 20mV per count. Each packet ends with a carriage return. This allows the PC to synchronize with the system. Since each packet is five bytes long, the system should be able to send 380 conversions-per-second which is quite fast for many purposes.

Some versions of the SX Key also contain an SX Demo board. This board has an RS232 level translator, and four pins that are suitable for analog input (remember, the analog-to-digital will all happen in software). I decided to make my circuit compatible with the board so it'd be easy to build the circuit, or just use the board as-is.

You'll find the complete code in Listing 1. If you are familiar with Microchip's assembler, you may find the syntax confusing. The SX-Key uses an assembler that resembles 8051 assembly. However, the basic machine code is identical (except, of course, for the SX's unique instructions). It is possible to use the Microchip assembler. However, you'll want to use the Key's debug-ging capabilities, so you might as

### Listing 1. The Data Acquisition System

```

Device
device pins28,pages1,banks8,oschs
device turbo,stackx,optionx
id 'DAS2'
reset reset_entry

Equates
tx_pin = ra.3
adc0_out_pin = rc.4
adc0_in_pin = rc.5
adc1_out_pin = rc.6
adc1_in_pin = rc.7
zero_offset = 8 ; subtracted from raw counts

Variables
org 8
temp ds 1
number_low ds 1
complete ds 1 ; bit 0 = 1 when complete
; holding for voltages
v0 ds 1
v1 ds 1
watch v0,8,uhex
watch v1,8,uhex

analog org 10h ; bank0 variables
= $
port_buff ds 1 ; buffer - used by all
adc0 ds 1 ; adc0
adc0_acc ds 1
adc1 ds 1 ; adc1
adc1_acc ds 1
adc_count ds 1 ; count for both ADCs
org 30h ; bank1 variables
serial = $

```

```

tx_high ds 1 ;tx
tx_low ds 1
tx_count ds 1
tx_divide ds 1

org 0

; Interrupt routine - virtual peripherals
interrupt
bank analog
; shifting the input bits aligns them with the output bits
mov w,>>rc ; read capacitor voltage
not w ; invert
and w,#%01010000 ; write to output
mov port_buff,w ; store it
mov rc,w ; and update pins

sb port_buff.4 ;adc0
incsz adc0_acc ;if it was high, inc acc
inc adc0_acc
dec adc0_acc ; inc/inc/dec prevents roll
sb port_buff.6 ;adc1
incsz adc1_acc ;if it was high, inc acc
inc adc1_acc
dec adc1_acc
inc adc_count ;done (8 bits)?
jnz adc_out

; Done so store results
mov adc0,adc0_acc
mov adc1,adc1_acc
setb complete.1 ;set complete flag

; clear for next pass
clr adc0_acc
clr adc1_acc

adc_out
; Begin UART VP
bank serial
clrb tx_divide.4 ;serial transmit
inc tx_divide ;only execute every 16th time
mov w,tx_divide
and w,$10
sz tx_count ;busy?
test tx_count ;ready stop bit
clc ;if busy, shift bits
sz tx_high
rr tx_high

```



well get used to using the Key's assembler.

## The UART VP

The Scenix web site shows several UART VPs. Actually, one of these VPs implements eight 19.2K UARTs! That's a bit of overkill for this application. There is another VP, however, that you can configure to operate between 2400 and 230.4K baud.

Nearly all VPs operate as an interrupt routine (usually from a timer interrupt). That means you'll often need to tweak them to work together. There are several things you must consider when integrating VPs with your program:

- How often must an interrupt occur for this VP to work?
- Does this VP require a constant time between interrupts?
- Does this VP use any resources already in use?

A UART, for example, requires a certain interrupt period to operate correctly. The typical VP interrupt handler does what it needs to do and then adds a negative number to the real-time clock counter. This forces the next interrupt to occur exactly when the interrupt routine wishes, even if the interrupt routine doesn't always take the same amount of time to execute. Of course, for this to work, the longest path through the interrupt handler must take less time than the inter-

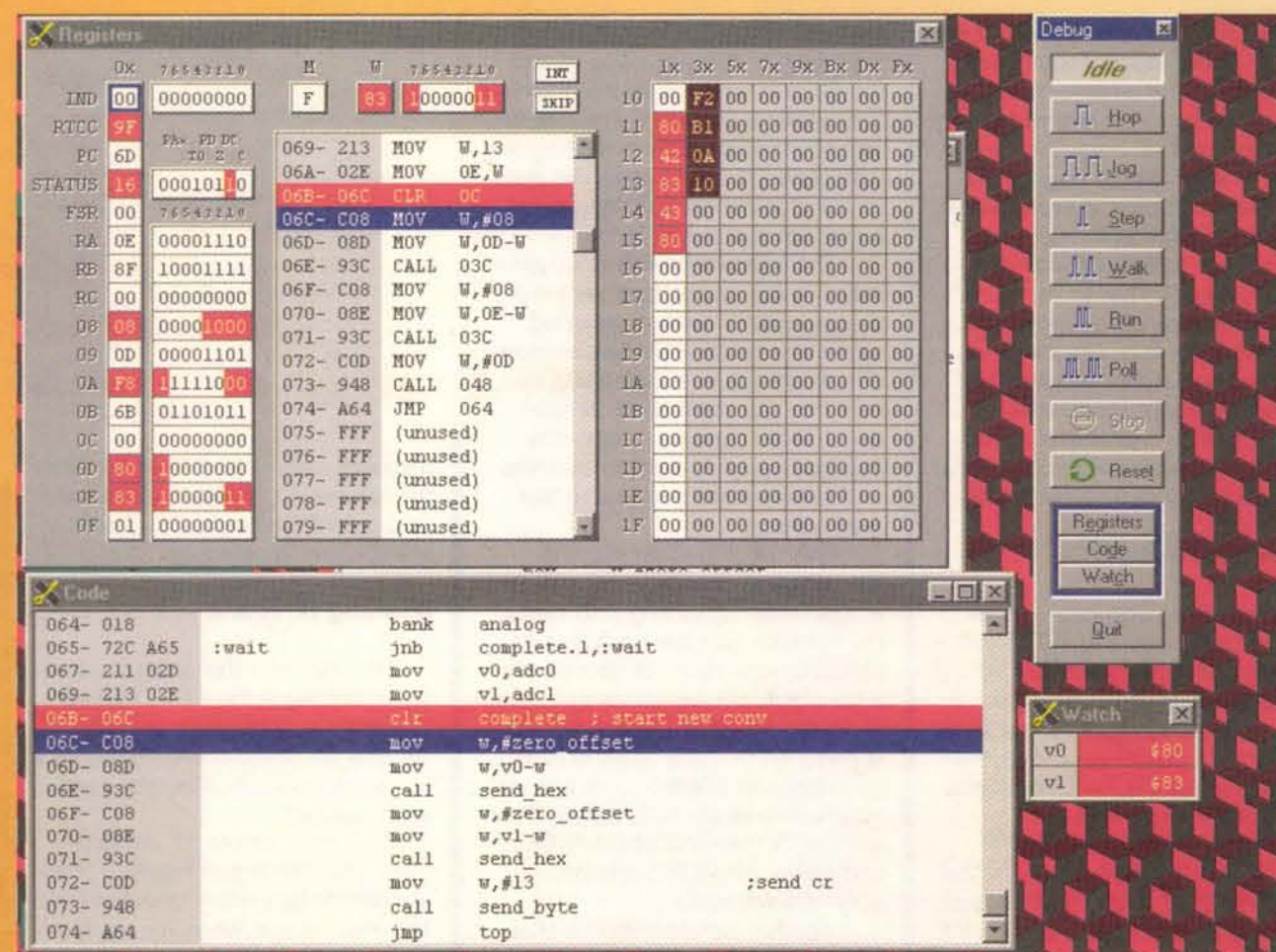


Figure 3. Debugging the System

rupt period.

Consider this example: Suppose your real-time clock increments every 20ns (as it will if you have a 50MHz turbo clock with no

prescale). If you do nothing, you'll get an interrupt every 5.12µs (256 counts). But what if you want an interrupt every microsecond? That should be easy — all you need to do

is to preload the counter with -50. Then when the clock generates 50 counts (1µs), the counter will go to 0 and the interrupt will trip again. There are two ways you could

```

SZ      tx_low
rr      tx_low
SZ      tx_count
dec     tx_count
movb    tx_pin,tx_low.6
; if busy, dec counter
mov     w,#-163
retlw   ; interrupt every 163 clocks

; Data
; required to output HEX numbers
hex     dw      '0123456789ABCDEF'

; Subroutines

; Send hex byte (2 digits)
send_hex
    mov     number_low,w
    mov     w,<number_low
    call    :digit
    mov     w,number_low
    ; send second digit
    mov     w,$F
    mov     temp,w
    mov     w,$_hex
    clc
    add     w,temp
    mov     m,#0
    iread   m,#$F
    ; read from program mem!

; fall into send byte

; Send byte via serial port
send_byte
    bank    serial
    wait    test    tx_count
            jnz     :wait
            not     w
            ; ready bits

; Main *
; Reset entry
reset_entry
    mov     ra,#%1000
    mov     ra,#%0111
    clc
    mov     rc,%10101010
    mov     m,$D
    mov     !rc,#0
    mov     m,$F
    ; init ra
    ; init rc
    ; set cmos input levels

    clc
    setb    fsr.4
    clc
    ijmp    fsr,loop
    ; reset all ram banks

    mov     !option,#%10011111
    ; enable rtcc inter-

; loop
    bank    analog
    jnb     complete.1,:wait
    mov     v0,adc0
    mov     v1,adc1
    ; wait for data ready
    ; capture it

    clc
    complete
    mov     w,#zero_offset
    mov     w,v0-w
    call    send_hex
    mov     w,#zero_offset
    mov     w,v1-w
    call    send_hex
    mov     w,$13
    call    send_byte
    jmp     top
    ; start new conv
    ; sub zero offset
    ; write out
    ; send cr

; main loop
    ; wait for data ready
    ; capture it
    ; start new conv
    ; sub zero offset
    ; write out
    ; send cr

```



do this. One is to load -50 into the counter at the start of your interrupt routine. The other is to use a special instruction to return from the interrupt. This instruction — RETIW — adds the W register to the real-time clock and performs a return from interrupt.

So if you loaded W with -50 and executed RETIW, you'll return and the counter will be poised to interrupt again in a microsecond. Because the number is added to the current counter contents, it doesn't matter how long the interrupt code takes to process (as long as it is less than a microsecond).

## A Software ADC?

It is easy to understand how you can implement a UART in software. But how can you make an analog-to-digital converter? The trick relies on some clever software and the SX's CMOS input threshold (you can select TTL or CMOS input thresholds in software).

When you select the CMOS input threshold on an input pin, that pin will respond to a 2.5V or higher level as a logic 1. Notice in Figure 1 that each analog input connects through a resistor to a capacitor. The capacitor also connects to an SX input and, through another resistor, to an SX output.

The ADC virtual peripheral sets up a periodic timer interrupt. On

each interrupt, the VP reads the logic level at the capacitor, inverts the bit, and writes it to the output. If the output is 0, the VP increments an accumulator. After repeating this 255 times, the VP stores the accumulator, which will be proportional to the voltage on the input.

The effect of all this is to generate a PWM voltage that will keep the capacitor's voltage hovering above and below 2.5V. The amount of time the SX is not pumping current into the capacitor is proportional to the amount of time the input is supplying current, and this must also be proportional to the input voltage.

This method is simple and allows you to calculate as many bits as you want. By cycling 256 times, for example, you can perform an eight-bit conversion. Of course, the least-significant bit will vary because of noise and other factors, but this is common in many types of ADCs.

With the 50MHz clock and an interrupt time of -163, the ADC can work with signals at about 600Hz and below. Above this frequency, accuracy will suffer.

Another consideration is that the input impedance of the ADC is relatively low (10K with the components used here). That means you must either account for the 10K resistor, or you'll need to use an op amp to isolate the input. The op amp's high input impedance will

minimize loading on the circuit while the low output impedance will prevent the ADC's resistance from affecting measurements much.

## Making it Work

You can find the entire system schematically in Figure 1. This configuration is compatible with the Parallax SX demo board so you can use it instead of building the hardware yourself.

You can see the SX development environment in Figure 2. This is a simple text editor with few frills. The real treat is when you want to troubleshoot your program. You can run the SX program directly from the development environment. The software programs the SX through a four-pin connector that connects to the SX clock pins. After programming, the SX hardware generates a clock at your choice of frequencies.

In addition to running the program directly, you can also initiate a debugging session (see Figure 3).



From here you can set a breakpoint, and examine or change registers. You can also single step code line-by-line.

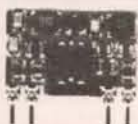
## Other Ideas

Although Scenix has a plethora of VPs available on their web site, there is nothing to stop you from writing your own. Scenix even has a program where independent companies can sell their own VPs.

Having a 50 or 100 MIPS microprocessor opens up a lot of new territory for designers. DSP-style software becomes possible at these speeds, and the SX is much less expensive than the typical DSP chip.

Of course, you can simply use the SX as a replacement for the PIC, and that's good, too. However, extra computing power is like extra cash; you can always find something to do with it! **NV**

# RF Data Modules



## AM TRANSMITTER

- Compact size: 17.78 x 11.43mm
- CMOS/TTL input
- No adjustable components
- Low Current, 4mA typical
- 418MHz or 433.92MHz OOK
- Simple to integrate—simply add antenna, data and power
- Range up to 250ft.
- Wide supply range, 2-14Vdc
- SAW controlled—stability
- Also available in DIL package

AM-RT5 ..... \$12.10



## AM RECEIVER

- Compact size: 38.1 x 13.7mm
- On-board data recovery, CMOS
- Low current, 2.4mA typical
- 2kHz data rate, CMOS/TTL output
- 5Vdc operation
- On 418MHz or 433.92MHz (4xx)
- No adjustable components
- Patented Laser Trimming component
- High stability
- Sensitivity: -105dBm
- Available also in 0.8mA version

AM-HRR3-4xx ..... \$10.95

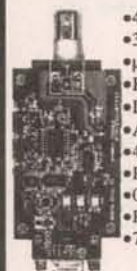


## FM TRANSCEIVER

- Only 23 x 33 x 11mm
- Up to 40k bps data rate
- 19200 baud with ASCII
- Up to 500ft. range
- 5v operation
- 0.25mW into 50
- 418 or 433MHz FM
- Fast 1ms enable
- Direct interface to 5V CMOS
- Auto TX/RX changeover

BIM-4xx-F ..... \$87.36

## RS232 TRANSCEIVER MODULES



- 4,800 to 38,400 bps half duplex
- 3-wire RS232 interface
- $\mu$ Controller with user EEPROM
- RS232 interface protected to  $\pm 15kV$
- Data packetizing performed by user
- Auto TX/RX changeover
- 418 MHz and 433MHz versions
- Range up to 500ft. (0.25mW ver.)
- 0.25mW & 10mW versions
- Reset switch and status LED's
- 7.5-15V dc via DB9 connector, 20mA

BIM-4xx-RS232 .... \$139.30



Transceiver.....  
Transmitter.....  
Receiver.....

- Up to 19,200 bps half duplex
- 3 wire RS232 interface
- Range up to 500ft
- Transparent data packetizing
- Supports 8 or 9 bit protocols
- Self test function
- Reset Switch & Status LED's
- 1/4 wave wire antenna on board
- Available in a Simplex Tx/Rx pair (RTcomTX & RTcomRx)
- 7.5V-15Vdc operation

RTcom-4xx..... \$247.90

RTcomTx-4xx..... \$ 87.15

RTcomRx-4xx..... \$105.52



**ABACOM**  
TECHNOLOGIES



Tel: (416)236-3858  
Fax: (416)236-8866  
www.abacom-tech.com  
abacomtech@compuserve.com

## Resources

**Scenix** — [www.scenix.com](http://www.scenix.com) (makers of the SX chip)

**Parallax** — [www.parallaxinc.com](http://www.parallaxinc.com)  
(makers of the SX-Key system)

**AWC** — [www.al-williams.com/awce.htm](http://www.al-williams.com/awce.htm) (macros that allow Microchip-like instructions with the SX key)

**Scenix Net Resources** —  
<http://www.svtehs.com/scenix.htm> (Alexy Vladimirov's page of links to Scenix material including free programmer designs)

**SXPoint** — <http://www.sxpoint.com>  
another page of links)

## Parts List

- C1, C2 - .1uF 25V capacitor
- C3, C4, C5, C6 - 1uF 25V electrolytic capacitor
- C7 - 100uF 25V electrolytic capacitor
- C8 - .01uF 50V ceramic capacitor
- IC1 - 28 pin Scenix SX (Could use 18 pin with minor software changes)
- IC2 - Maxim MAX232
- IC3 - 7805 or 78L05
- J1 - 4 pin header (for SX Key programmer)
- J2 - DB9 connector
- R1, R3, R4, R5, R6 - 10K 1/4W resistor
- R2 - 33K 1/4W resistor
- Y1 - 50MHz ceramic resonator with capacitors (Murata CST50.00MX040)



# OUT OF SIGHT HIGH-FREQUENCY ANTENNAS

by Gordon West

In a few more months, the Federal Communications Commission will take action on their proposed Docket 98-143 to restructure the amateur radio service and allow worldwide high-frequency General class privileges at a slower Morse Code test speed.

The General class code test will probably be 5 wpm, and any Technician-Plus ham operator may be instantly grandfathered to the new worldwide high-frequency General class band privileges. Technician no-code operators would

simply learn the code at 5 wpm and, they too, would fall into those new worldwide General class privileges.

Or maybe there might be one additional General class theory test involved — Element 3B. This is a relatively easy multiple-choice test to pass, so everyone in the industry is anticipating a major influx of Technician class operators to worldwide high-frequency band privileges.

High-frequency equipment manufacturers like Yaesu with their new FT100, ICOM with their new IC-706G, Kenwood with their 50, and Alinco with their 70 are ready with equipment for immediate dealer sales. In fact, most manufacturers agree that high-frequency radio sales are up to Technician class operators anticipating their new General class privileges.

## THOSE ANTENNAS

Getting onto the high-frequency bands requires big antennas. The simple dipole is easy to construct and, for 10 meters, the end-to-end length is 16 feet. But for 40 meters, the unloaded dipole is now 64 feet tip-to-tip, and you can double that for the popular night-time 75-meter band.

The simple dipole is an inex-

pensive way to get onto all worldwide General class bands with a terrific signal, but they do require a sizeable amount of open space for big attic runs and, because of their length, they put RF everywhere in the household.

The long dipole will also pick up household noises, too. This would include the FAX machine, "smart" telephone systems, the computer, electronic thermostat, florescent lights, and a variety of other household appliances that may now incorporate a micro-computer chip on the inside. There is no easy way to minimize this noise pick-up, other than to isolate your antenna away from the attic area.

## WORKS BEST

If you live in a house and there are no city restrictions on big ham antennas, go ahead and put up a compact three- or four-element beam. This could give you 10 through



PHOTO A. 6' STEPLADDER.

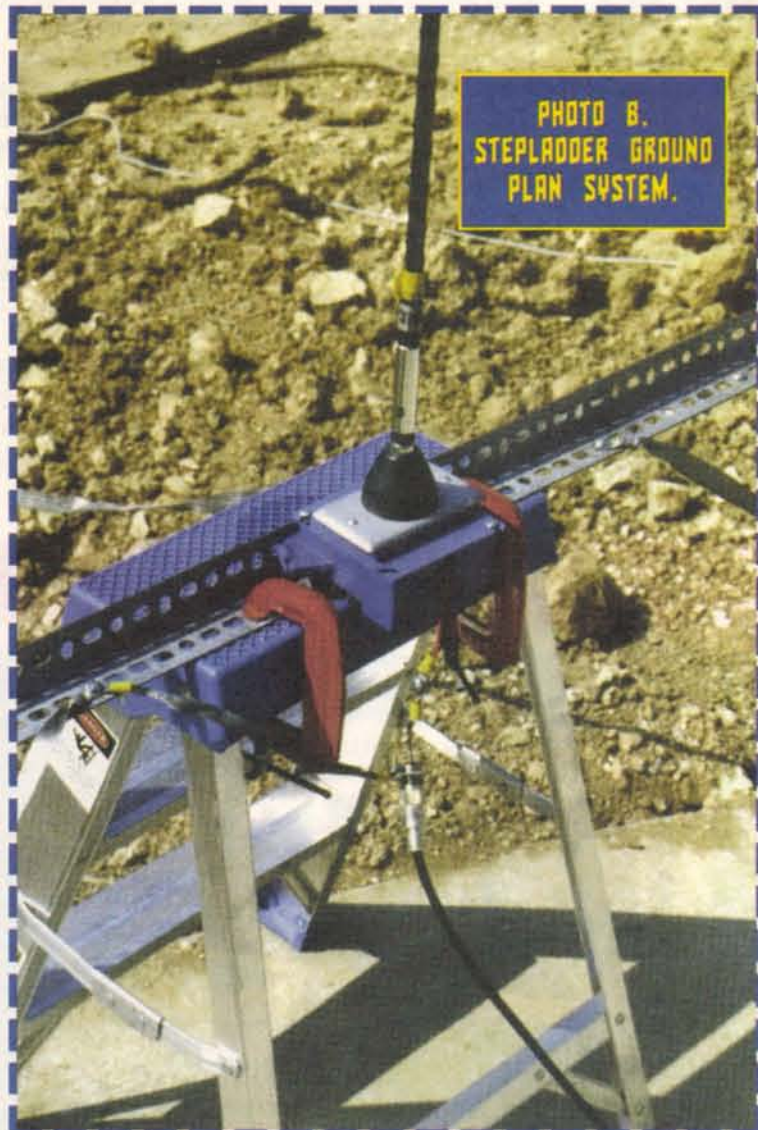


PHOTO B. STEPLADDER GROUND PLANE SYSTEM.

SGC tuner and model 303 whip antenna for a completely automatic tune-up.





40 meters, and your 75- and 160-meter dipole would give you the two additional lower bands. The big beams from leading manufacturers are not difficult to construct, just as long as you follow the assembly instructions. We recently put together a Cushcraft A4 with the 40-meter add-on dipole kit, and we had everything up in the air and playing by late afternoon with an 8:00 a.m. morning start. Three of us were working on the project, so if you do it by yourself, it's going to take you a couple of days to get the big beam operational on high frequency.

## MAGNIFICENT MOBILE ANTENNAS

Amateur radio operators love to experiment with mobile high-frequency antennas operated in the attic or their backyard. Mobile antennas are traditionally helical or center-loaded to minimize their length; and when configured end-to-end as a dipole, they work well for single-band operation. You can also take that mobile whip, counterpoise it off of a metal ladder, tripod, or iron railing, and achieve fantastic transmission and reception, especially if you are near water or in an area with good ground conductivity.

Amateur radio operator Don Wilson N9ZGE (2908 Dartmoor Court, Springfield, IL 62704-6469), has achieved fabulous results from mobile antennas in his backyard; some of the photos appeared in this publication



about a year ago. We received so many letters about "How well did it work?" I thought we would take some of his best experiments and review the potential results.

### LADDER ELEVATED DIPOLE (PHOTO A)

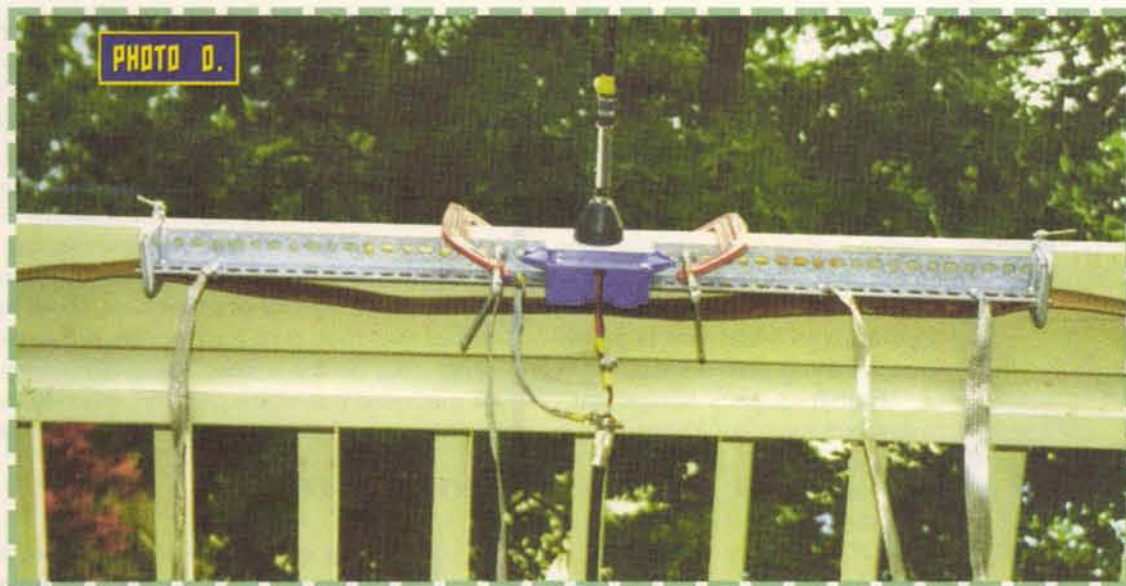
"Here's how I use a six-foot stepladder to mount a variety of mobile antennas, fed end to end as a dipole, in a temporary backyard set-up. Note that the ladder is chained

down to a screw anchor," comments Wilson. Since the ladder is used just for support, a wooden ladder would work fine, and this arrangement will lead to good single-band operation on 10, 12, 15, and 20 meters. For 40 and 75 meters, I would think that the dipole would need to be raised a lot higher.

### VERTICAL WITH GROUND COUNTERPOISE (PHOTO B)

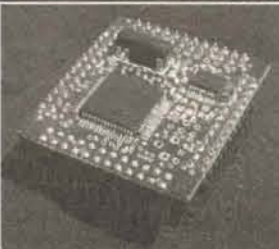
Here is a classic stealth antenna set-up that will drive a shortened HF quarterwave whip into a perfect 50-ohm match against one-quarter wavelength, or greater, counterpoise. Here we see an aluminum ladder with two quarter wavelength metal ribbons for each band of desired operation. The natural downslope of the aluminum ladder helps improve that 50-ohm match. The whip could also be mounted on a metal bar across a picnic table (Photo C) or even on a railing (Photo D) with terrific results.

"I use the RADIO WORKS line isolator to keep RF from coming back into the shack on the outside of the coax shield," comments Don Wilson. "In the stepladder set-up, I use a Kenwood TS50S, a Kenwood AT50 tuner, and an 80-meter ham stick that I retune for different bands," adds Wilson. Although automatic antenna tuners, as well as manual antenna tuners, can do wonders for fooling a radio



## UNI-MICRO™ Super-Small-Low Power

The NEW UNI-MICRO series of modules provides a complete ready to use single board computer on a 1.75" X 1.5" module with large amount of non-volatile flash based memory. Expanded capabilities, multiple serial busses, In-circuit programming, including first time programming and a very low power consumption of 58 mA, makes this series of modules perfect for instrumentation, monitoring and control applications.



### Microcontroller Design Made Simple

Small • 80C51 code compatible • 256 x 8 ram • 2K x 8 Battery backed sram with automatic power switching • 128K x 8 Flash memory • Parallel or serially programmable • 32K x 8 Flash memory • 3 16 bit timers • One 8 channel 10 bit A/D converter • Two 8 bit PWM outputs • One full duplex UART • 16 Mhz speed • 3000 gates flash CPLD • IIC serial bus • JTAG bus • 54 configurable I/O pins • RS232 driver on board • Voltage regulator on board • Power-on reset • Program security • Very low development costs • Assembly, C, Basic programmable.

\$59

**OS Systems** 770-955-6101 <http://www.ossystems.net>  
2600 Bentley Rd. #1806 Marietta, GA 30067

PRODUCTS FEATURES ORDER NEWS LINKS

**Black Feather ELECTRONICS**

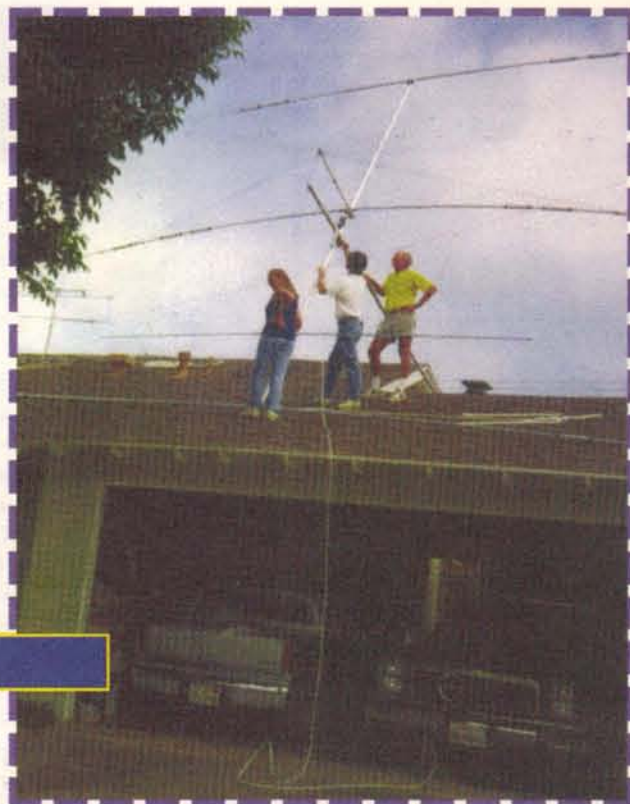
Black Feather Electronics  
10841 Noel St. #106  
Los Alamitos, Ca. 90720

DIRECT DIAL: (714) 236-1776 FAX: (714) 236-1778 E-MAIL: [blktea@juno.com](mailto:blktea@juno.com)  
**WWW.BLKFEATHER.COM**  
WE BUY EXCESS/SURPLUS ELECTRONIC SUPPLIES





Author West and friends putting up the Cushcraft A4 beam.



into full output, I always recommend using the right whip for the specific band of operation.

Alpha Delta Communications (Manchester, KY; 606-598-2029) produces an excellent metal tripod specifically for mounting their Outbacker antenna where the tripod acts as the active ground plane counterpoise. The tripod can quickly be deployed, and Don Wilson indicates it is a good solid performer.

#### FOLD-DOWN

Alpha Delta Communications also has a unique fold-down antenna system specifically designed for permanent installation of an all-band, high-frequency vertical.

It will raise and lower a vertical, up to 29 feet and 25 pounds in weight, and includes a hydraulic dampener to prevent the antenna from coming down too fast. But keep in mind that this is a permanent installation, and you won't be able to easily move it from one home to another without digging another big hole! (See Photo D.)

#### AUTO-TUNED WHIP

SGC produces an automatic antenna tuner that covers 160 meters through six meters, and allows their Model 303 whip to be automatically tuned from a ground-

mounted counterpoised installation. Don Wilson sends along several photos showing how this set-up works in his backyard, and



Alpha Delta fold-down antenna system.

## PRINTED CIRCUIT BOARDS

**QUALITY PRODUCT**  
**FAST DELIVERY**  
**COMPETITIVE PRICING**

**PROTOTYPE THROUGH PRODUCTION**

**PULSAR, INC**

9901 W. Pacific Ave.  
Franklin Park, IL 60131  
Phone 847.233.0012  
Fax 847.233.0013  
Modem 847.233.0014  
yogii@flash.net • flash.net/~yogii

- \* UL approved
- \* Single & Double sided
- \* Multilayers to 8 layer
- \* SMOBC
- \* LPI mask
- \* Through hole or SMT
- \* Nickel & Gold Plating
- \* Routing or scoring
- \* Electrical Testing
- \* Artwork or CAD data
- \* Fast quotes

## SATELLITE TV – HACKERS 'BIBLE'!

### The SECRETS are REVEALED!

- The principles of security
- Descrambler building blocks
- Smart cards, information wars & stupid mistakes
- Cracking codes (includes DirecTV source code)
- Installing and hooking up descramblers
- Video manipulative systems...and much more...

**www.baylin.com**  
**or... call 800-483-2423**

ORDER via Internet or Send \$60 plus \$5 s/h to:  
Baylin Publications, 1905 Mariposa, Boulder, CO 80302  
MASTER, VISA & AMEX /COD orders accepted



576 pages, 6" x 8-1/2"

**NEW!**  
**5th Edition**

Telephone: 303-449-4551  
FAX: 303-939-8720

**FREE CATALOG – Satellite TV books, videos and software**





**The ladder  
elevated HF loop  
system.**

restrictions in our subdivision, but with all of these great antennas in my backyard, no antennas are visible," adds Wilson.

Wilson has also experimented with high-frequency loop antennas, and these he mounts on that fiberglass stepladder, and concedes that the higher up the loop is off the ground, the better it performs.

"The W9INN multi-band dipoles are another good way to go for a stealth antenna, maybe placed in an attic," comments Bill Alber WA6CAX. Bill recommends that all radio experimenters send a couple of bucks for postage to W9INN, P.O. Box 393, Mount Prospect, IL 60056 (708-394-3414) for his many informative sheets on multi-band dipoles. Bill also indicates that [www.radioworks.com/nbgnd.html#counterpoise](http://www.radioworks.com/nbgnd.html#counterpoise) is another great source of information from Radio Works, Inc. I have ordered a lot of prod-

ucts from Radio Works, and they really know their antenna business from the importance of a ground on up.

Some of the most popular whips are those you see at the hamfest that are helical center-loaded, with a stainless steel stinger. Valor, Ham Sticks, and Hustler traditional white center-loaded mobile antennas are popular choices among backyard experimenters.

the beauty of the SGC installation is instant band changes without needing to go out and re-adjust the whip or change resonators.

"My home base station consists of a Kenwood TS870S, Henry 2K classic amplifier, MFJ 960 tuner feeding a MPD-2-105 dipole from W9INN Antennas, with ladder line," comments Wilson.

"As you might guess, we have antenna

I like the Outbacker from Alpha Delta because all bands are on a single whip, and you simply re-adjust the fly-lead for a specific band of operation.

More good hints for portable mobile-whip operation in the backyard is to keep dipoles as high off the ground as possible, and as far away from the side of your dwelling as possible.

For single whips off of a ground counterpoise, dry soil usually won't do the trick — you must have metal, or quarter wavelength wire strips. If you have aluminum or wrought iron railings, your ground plane is all set, and you can angle your mobile antenna off of the ground plane almost any way you want.

The bigger the antenna, the better the performance. The Alpha Delta Australian Outreach puts in about an S-unit better signal to a distant station than its smaller brother, the Alpha Delta Outbacker. And when you compare all of these expensive mobile antennas to a simple dipole you can make yourself with just #16 stranded wire, the dipole will usually do the best job of them all.

So have fun in the backyard, always wear protective glasses when working around antennas, and caution everyone to stay well away from the antenna when you are transmitting.

*Think safety, and have fun on the high-frequency bands. NV*



# You Win with Nuts & Volts

Subscribe today and be  
automatically entered in our  
new MONTHLY PRIZE  
DRAWING!!!

*April Prize Winners:*  
**Bruce Cooke**  
of Blountville, TN  
**Rich Stolte**  
of Norcross, GA

JUNE DRAWING HOSTED BY  
**ELECTRO-MAVIN**  
(see page 36)  
2 SEAGATE 2.1GIG SCSI  
DRIVES MODEL ST42100N

**SPECIAL BONUS:**  
**NETCOM** (page 11)  
WILL FURNISH PRIZES  
MONTHLY!!

## Contributors ...

**Parallax** (back cover) • **Corporate Systems Center**  
(pages 2,99) • **HSC** (page 3) • **Resources Unlimited**  
(page 33) • **Timeline, Inc.** (page 81, May issue) • **Alltronics**  
(page 64) • **Electro Mavin** (page 36) • **All Electronics**  
(page 60) • **Roger's Systems Specialist** (page 55)  
• **Electronic Goldmine** (page 56) • **MCM Electronics**  
(page 31) • **Velleman** (page 40)

Check us out on the web!  
<http://www.nutsvolts.com>

If you do not wish to order a subscription, but would like to be entered in our drawing, simply send or E-Mail your name, address, and telephone number, to NUTS & VOLTS, 430 Princeland Court, Corona, CA 91719, [drawing@nutsvolts.com](mailto:drawing@nutsvolts.com). No phone entries accepted. All orders/entries must be received by the last day of the month to be included in that particular month's drawing.

As a current, paid subscriber, you will be automatically entered each month in our drawing.

**To Subscribe** — Just fill in and mail the enclosed subscription card or call our toll free order line at (800) 783-4624 with a Visa or MasterCard.



Continued from page 46

**TOCOM UNMODIFIED 5503 CABLE CONVERTERS UNTOUCHED.** \$6 EACH. 10 LOT MIN. CALL 706-657-4445.

**WANTED: GENUINE RAW UNMODIFIED CABLE TV CONVERTERS. TOP CASH PAID.** CALL 708-715-6118.

**POSITIVE NOTCH filters.** Channels available: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, and 25, \$16 each. Channels 26, 27, 28, 29, 30, and 31, \$19 each. Channel 39 \$25 each. Order by single channel. Top quality non-tunable metal cylinder types. 75dB deep on notch. Need to block the video on a cable channel til the kids do their homework, order a negative notch filter from our company. We carry large stock on all channels. Visa, MasterCard, Discover and UPS COD. "The Filter Company" Quantity pricing on 5 or more. 100 pcs. \$7 each. Call 1-800-235-8080. On the web go to [www.gofilters.com](http://www.gofilters.com) lots to see. Open 8am to 5pm Central Standard Time, Monday-Friday. All sales must comply with FCC 1996 cable act.

**PICS, GALS READ** if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

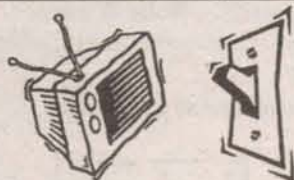
**CABLE BROKERS** is representing 2 cable companies that have filed bankruptcy and we are liquidating their assets. We have on hand 4,000 Tocom 5503 VIPs. These units are unmodified and are in good condition. We also have the complete headends. Also we are representing a Zenith system with various levels of good, unmodified units mostly ST1600 starting at \$22. We would like an offer on the VIPs 550 and 450MHz mixed. However, we will sell 100 lots at \$14 each. We can fax you a detailed list. Call Jesse at Cable Brokers, Inc. 1-888-757-1757.

**CABLE BOX** repairs and upgrade. Most models, warranty lowest prices. Call 214-695-5982.

**DTV & DISH NETWORK INFORMATION (33 PAGES)** only \$15. Mainline Electronic, Inc. Free cable information included. Playstation & Nintendo 64 games at wholesale prices. Visa & MasterCard accepted. Call toll-free 1-877-539-9896.

**CABLE TV. Panasonic TZPC 175DG2**, brand new, \$80 w/volume, 1 year warranty, minimum 10 pcs. any qty., plus all major brands available. Lowest price new/field pulls. E-Mail: [OCALA@BELL SOUTH.NET](mailto:OCALA@BELL SOUTH.NET) phone: 1-800-929-1549 fax: 305-220-9396

**CABLE CONVERTERS, DBS, remotes, schematics, etc., free flyer.** Jake 419-385-3100.



**EXPLOSIVE CABLE TV GRAB!** BRINKER ZAPPER/SNOOPER STOPPER combo module all in one! Buy wholesale factory-direct, no middleman. Let others get, fined & zapped instead. 100% COMPATIBLE. Your order shipped NATIONWIDE immediately! LIFETIME GUARANTEE! VISA/MC/AMEX/COD/MO/CHECKS. ONLY \$10 (SPECIAL: 3/\$20 plus FREE DESCRAMBLER PLANS!). SUPER ZAPPER MODULES ONLY \$16! (3/\$33)! Use SUPER ZAPPERS if you have COX, TCI, WARNER in: CA, TX, FL, NY, PA, MI. DESCRAMBLER PLANS (4=\$5, 20=\$15) 130+ DESCRAMBLER SOURCES (\$5). FREE SHIPPING. OPEN 24 HOURS! 352-429-5496. BRINKER ENGINEERING LABS, USA.

**ATTN. DEALERS:** Are you a current dealer or just getting started? Buy factory direct & save \$. New 181 and 125 channel converters, major brand name cable converters & all other accessories not listed, no more delayed shipments. All products 6 month warranty, 30 day money back. A & S Wholesale, 1-800-370-0801.

**PLANS: DESCRAMBLE CABLE FOR UNDER \$12. PLUS TWO FREE BONUSES. TOLL FREE 1-888-588-3715.**

**CABLE PARTS!** Computer parts. Call for great prices or visit us on the Web: [HTTP://WWW.CB-Electronics.com](http://WWW.CB-Electronics.com) or call 1-800-436-8630.

**TOCOM UNMODIFIED 5503 CABLE CONVERTERS UNTOUCHED.** \$6 EACH. 10 LOT MIN. CALL 706-657-4445.

**TUNERSTOCOM 5503** tested \$4.75 ea., bargain, 10 lot min. Call 706-657-4445.

**CABLE BOX COVERS TOCOM 5503**, good condition \$3.75 ea. 20 lot min. Call 706-657-4445.

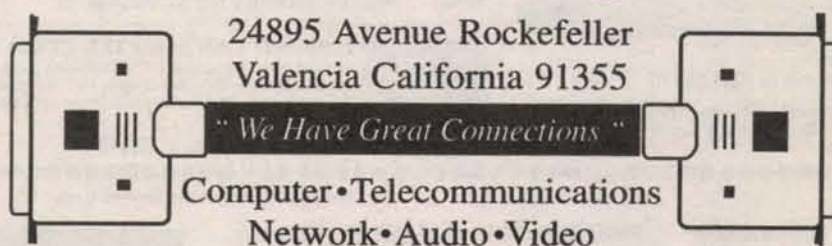
**PLAIN CONVERTERS:** Brand-new, the most reliable in the market today. Philips ECG-TV-3000, 181-channel only \$75 ea.; Refurbish Panasonic TZPC-145, \$35; Panasonic-TZPC-175, \$39 minimum 10-lot, 1 full year warranty, same day shipping. 405-634-1535.

**SONY PLAYSTATION MODCHIPS.** Allows playing of CDR backups & imports. \$10 + \$3 shipping. 619-590-9320.

**GENUINE UNMODIFIED JERROLD DPBB 7312.** 1-800-804-8655. E-MAIL: [CLEWIS7298@AOL.COM](mailto:CLEWIS7298@AOL.COM)

**DESCRAMBLE CABLE TV!** Learn all the cable hacker secrets and everything the cable company has to hide! Send \$10 and SASE: CATV Secrets, PO Box 327, Hutchinson, KS 67504. (Check/MO payable: Mr. Adam Henson.) Visit GhettoMart on the web: <http://www.cyberweb.org/adamsghettoMart/>

## Rogers Systems Specialists



24895 Avenue Rockefeller  
Valencia California 91355

Computer • Telecommunications  
Network • Audio • Video

[www.rogerssystems.com](http://www.rogerssystems.com)



### Category 5 Patch Cables

TE-068-L5X	7 ft. Crossover	\$2 <sup>00</sup>
TE-068-L5	7 ft. Straight Patch	\$2 <sup>00</sup>
TE-508-L5	50 ft. Straight Patch	\$10 <sup>00</sup>
TE-108-L5	100 ft. Straight Patch	\$20 <sup>00</sup>

### USB Cables

CC-USB-6	6ft. USB "A" to "A" M/M	\$5 <sup>00</sup>
CC-USB-AB6	6ft. USB "A" to "B" M/M	\$5 <sup>00</sup>
CC-USB-PP	6ft. USB to IEEE Printer Cable	\$39 <sup>00</sup>
CC-USB-6	6ft. USB "A" to "A" M/F	\$5 <sup>00</sup>

Call for 10 & 15 foot lengths!

### USB Accessories

CC-USB-8	USB (2) to 2x8 pin w/ Bracket	\$5 <sup>00</sup>
CC-USB-9	USB (2) to 2x5 pin w/ Bracket	\$5 <sup>00</sup>
USB-PCI	USB x2 PCI Add on Card	\$27 <sup>00</sup>
USB-KB-104	USB 104-Key Kybrd Win98/PS2	\$39 <sup>00</sup>
USB-MOUSE	3-Button USB Mouse 4200dpi	\$12 <sup>00</sup>
USB-CAM	C-IT USB Cam w/ Software	\$109 <sup>00</sup>

### Clip/Stick-on Lapel Microphone

TM-MIC-2

### Network Cards

NT-TBT-10	10-Base 16Bit ISA Slot Card	\$14 <sup>00</sup>
NT-TBT-100	PCI NE-2000 Comp 10/100	\$21 <sup>00</sup>
NT-TBT-200	PCI NE-2000 Comp. Ethernet	\$14 <sup>00</sup>
NT-TBT-3C905B	3COM 3C905B-TX 10/100 PCI	\$72 <sup>50</sup>

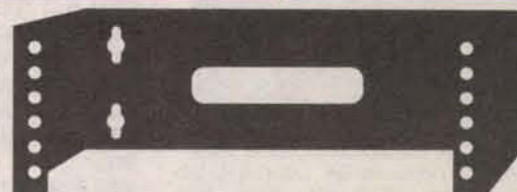
### External SCSI Case

TM-CASE-HDS \$15<sup>00</sup>  
Limited to stock on hand

## Mice



TM-290	3-Button Serial DB9	\$6 <sup>00</sup>
TM-290-2	2-Button Serial DB9	\$6 <sup>00</sup>
TM-290-Mic	PS/2 MS Mouse OEM	\$29 <sup>00</sup>
TM-290-Net	Designer Netmouse PS/2	\$5 <sup>00</sup>
TM-290-PS	PS/2 2-Button 6-pin Din	\$6 <sup>00</sup>

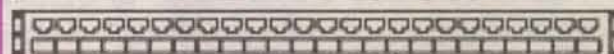


### Hinged Brackets

HB1	19" wide/ 1.75" tall	\$7 <sup>00</sup>
HB2	19" wide/ 3.5" tall	\$9 <sup>00</sup>
HB3	19" wide/ 5.25" tall	\$10 <sup>00</sup>
HB4	19" wide/ 7.00" tall	\$11 <sup>00</sup>
HB6	19" wide/ 10.5" tall	\$14 <sup>00</sup>
HB8	19" wide/ 14" tall	\$17 <sup>00</sup>

We'll Beat anyone's price on these Brackets!

## Patch Panels



PP-24P-5	24 Port Cat5 Patch Panel	\$67 <sup>00</sup>
PP-48P-5	48 Port Cat5 Patch Panel	\$124 <sup>00</sup>

## Transceivers



AUI/DB15 - BNC/10 Base2	\$10 <sup>00</sup>
AUI/DB15 - RJ45/10 Base T	\$10 <sup>00</sup>

800-366-0579 661-295-5577 Fax 661-295-8777



## STEREO SOLAR RADIO

Attention outdoor enthusiasts, this is the solar radio for you! The receiver weighs in at only 3 1/2 oz and has a built in nicad that is charged by the sun! When fully charged, this nicad powers the radio for 4 hours. We were amazed by the great reception and sound quality that this ultra portable unit produced! For extended use indoors or at night, an AAA battery (included) can increase the continuous playing time to approximately 80 hours. The radio comes with 2 arm bands (one black and one fluorescent orange) to attach the receiver to your arm while walking, jogging, exercising, etc. Features adjustable AM/FM stereo reception and adjustable volume control and includes a lightweight pair of headphones. Size of unit is approximately 2 1/4" X 3 1/2" X 3/4". Brand new in retail blister pack. A must have for every Y2K survival kit!

G1423 \$14.95 ea.



Get Ready For Y2K

## SMALL ENCAPSULATED SOLAR CELL

Small silicon solar cell mounted on an insulated base and then fully encapsulated. Great for making super sensitive light activated projects or connect several in series to charge a super cap and make a tiny solar robot. Output is 1/2 Volt at 5 milliamperes. Diameter is 5/16".

G1440 \$1.00 ea.

## SUPER SENSITIVE PHOTODARLINGTON TRANSISTOR

Made by Everlight these silicon photodarlington transistors are perfect for thousands of applications in people detection circuits, robotics, machine automation, etc. Type PDT323-5 has a black 5mm case with 2 full length leads. Brand new - prime on tape & reel. Super blowout price!

G1450 10/\$1.00 • Full reel of 1000/\$80.00

Now in our 10th year of business, we are pleased to announce that we have over 5,000 products for sale. If you would like our full line catalog call or send for one today. Free to USA addresses or send \$5 if out of USA.

Special Purchase!



## "AS IS" CORDLESS 25 CHANNEL TELEPHONE WITH CALLER ID

This was a very high tech cordless phone made by Pacific Bell. It automatically selects the clearest channel. It has a compander to reduce noise and static, it indicates new calls and voice mail. It stores up to 50 names and numbers on the built in LCD display for caller ID plus it has speed dial and auto call back of any stored number. The base unit even has a paging button so that you can be summoned. The only problem is that these are as is units and when they were sent back the service center removed - 1.) the battery from the handset (you can buy a replacement from RS) 2.) the screw in antenna on the handset only - the base unit still has an antenna, and 3.) the 9V 150ma adapter. We do not test them and we do not have any instructions for use so we are selling them "as is" only - they may or may not work if you screw in an antenna add a battery and connect up an adapter to the base unit. You do get a used high quality base unit and a matching used handset! Please no returns. These were probably \$200 phones!

G1425 Black \$7.95 ea.

G1426 White \$8.95 ea.

## OUR TINIEST MOTOR

Tiny super efficient motor is great for making tiny solar powered robots. These are brand new motors made for the "vibrator" function in pagers. The body is only 9/16" long x 1/4" dia. Attached to the shaft is a "D" shaped weight, which you can insert into the center of a small plastic wheel, and you have a drive unit for a tiny robot that you can power from a hearing aid battery, a solar cell, etc.

G9599 \$5.95 ea. • 2/\$10.95 • 100/\$500.00

## SUPER BRILLIANT 3 COLOR LEDs

These clear lens T1 3/4 3 lead right angle PC mount LEDs light up bright green, bright orange or if both internal LED chips are powered it lights up a bright yellow orange. This is one of the brightest and attractive LEDs we have seen. Made by LUMEX part #SSF-LXH169IGC. Prime!

G1445 4/\$1.00 • Factory bag of 500/\$100.00



## LIGHTED CAR ADAPTER CORD

Standard car adapter cord for 12V cars lights up a bright red (to show you that the socket has power) when plugged into your cigarette lighter socket. The adapter has a 5ft cable and a 5mm female barrel plug with "+" center. Brand new.

G1431 \$2.00 ea. • 10/\$15.00

Write in 78 on Reader Service Card.

**RAW CONVERTERS:** We have the best quality to your cable needs. PI-5135 \$45 ea.; Zenith ST-1600 \$75; S/A 8590 (11-B) \$85 ea.; S/A 8590 (10-B) \$75 ea. Please call for others not listed. 405-634-1535.

**UNBELIEVABLE PRICES.** We carry a full line of cable tools and equipment for all your cable needs. Also a wide variety of electronic parts & accessories, tools, diagrams, converters, step-by-step instructions, no raw parts, full technical support. 12pm-7:30pm EST 1-800-562-8442.

**CABLE DESCRAMBLER plans!!!** Plus two free bonuses: radar jammer plans & cable manual, \$14. 1-888-367-9972.

## TELEPHONE/FAX

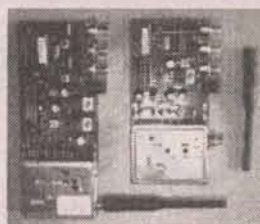
**TELEPHONE CATALOG** 160 pages including office automation, voice mail, and all phone accessories. Send \$10 to HES Electronics, POB 183, Brick, NJ 08723. A 10% off certificate will be included! Visit [www.heselectronics.com](http://www.heselectronics.com)

**PHONE SYSTEMS WANTED!!!** We buy AT&T MERLIN, SYSTEM 25/75/85 and other AT&T phone systems. Please call for a quote or fax us your equipment list. **KEYWAYS, INC.,** 937-847-2300 or FAX 937-847-2350.



**CELLULAR CLONING COLLECTION.** 1999 CELLULAR CLONING INFO BIBLE \$22, 1999 CELLULAR CLONING SOFTWARE COLLECTION \$33, 1999 CELLULAR SECRETS & PROGRAMMING MANUAL \$11. ALL 3 FOR \$44, WOW!! (SAVE \$22). FOR EDUCATIONAL/TECHNICIAN TESTING USE ONLY. (VISA/MC/AMEX/COD). OPEN 24 HOURS! 352-429-5496. **BRINKER ENGINEERING LABS, USA.**

## COMPONENTS



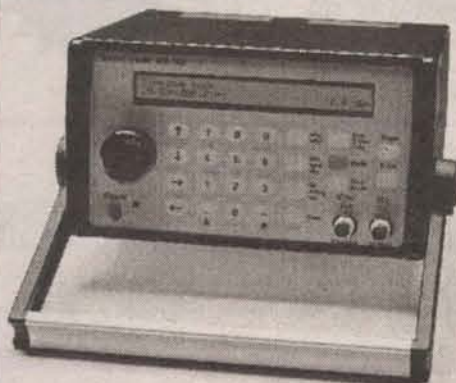
**2.4 GHz/1.2 GHz VIDEO TRANSMITTER & RECEIVER** designed exclusively for HAM ATV bands. 8 switchable frequencies; F/SMA type connectors with two 1/4 wave rubber-duck antennas included; 100 mw output power. Receiver has greater than -80 dB sensitivity. Price \$119. Related camera, video, and security systems also available. Two additional audio channels can be used for digital data applications. Due to high response, please contact by E-Mail: [info@4atv.com](mailto:info@4atv.com) Website: [www.4atv.com](http://www.4atv.com)

**SEE OUR ad on 4-channel 2.4GHz wireless system in the AdMart section on page 73. Matco, Inc.**

**NEW 1999 catalog:** Inductors, toroids, TC ceramic and Mica capacitors, semi-conductors, wire and cable, hardware, more. Two stamps please. Johnson Shop Products, Box 2843, Cupertino, CA 95015.

**Now your subscription to Nuts & Volts pays you with discounts on popular electronics books. See page 9 for details!**

## Any waveform you want!

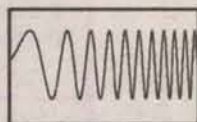


**Telulex Inc. model SG-100A**

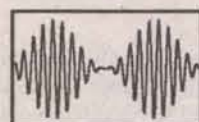
**New Features:**  
✓ 21.5 MHz  
✓ .01 Hz steps  
✓ multi-unit phaselock

- **Synthesized Signal Generator**  
Clean sinewaves DC-21.5 MHz with .001% accuracy! .01 Hz steps. DC Offset. RS232 remote control.
- **Arbitrary Waveform Generator**  
40 Megasamples/Second. 32,768 points. 12 bit DAC

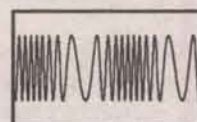
- **Function Generator**  
Ramps, Triangles, Exponentials, Noise & more. 0 to 2 MHz in 1 Hz steps. Continuous or Triggered.
- **Pulse Generator**  
Digital waveforms with adjustable duty cycle



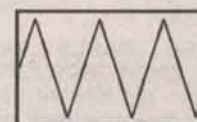
DC to 21.5 MHz linear and log sweeps



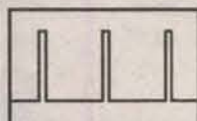
Int/Ext AM, SSB, Dualtone Gen.



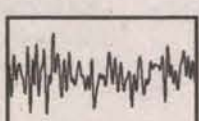
Int/Ext FM, PM, BPSK, Burst



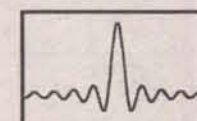
Ramps, Triangles, Exponentials



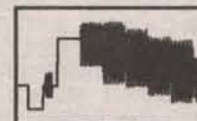
Pulse Generator



Noise



Arbitrary Waveforms



Unlimited Possibilities!

**Telulex Inc.**

2455 Old Middlefield Way S  
Mountain View, CA 94043

Tel (650) 938-0240  
Fax (650) 938-0241

<http://www.Telulex.com>  
Email: [sales@Telulex.com](mailto:sales@Telulex.com)



**OLD ICs & TRANSISTORS WANTED:** HIGHEST PRICES PAID please FAX your list with part number, quantity & condition of any semiconductors to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! www.electronic surplus.com

**RF TRANSISTORS, TUBES, 2SC2879, SD1446, MRF455, MRF454, 3SC1969, 2SC2166, 2SB754, TA7222AP, 2SC1419, 2SC1947, 2SB688, 2SD880, MRF422, MRF448, MRF247, MRF317, SAV7, SAV17, 3-500ZG 4CX250B, 572B, 3CX3000A7, 4CX400A** silver mica caps, resistors, electrolytics, etc. Westgate 1-800-213-4563.

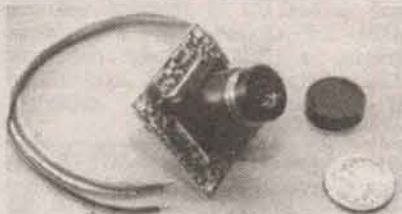
**WANT TO Buy:** ICs, military & aircraft relays, diodes, transistors, Cannon, TRW, Amp, Burndy, Deutsch, Bendix connectors, electronic test equipment & most components. Hoffy Electronic Ent., 818-718-1165, FAX 818-341-5506.

**RESISTOR SACRIFICE:** 10,000 quarter-watt metal and carbon film. One, two, and five %. 1 ohm to 22 megohms. **FIFTY** each of **TWO HUNDRED** different values. \$45 (less than one-half cent each). Hyatt Surplus, 371 N. Johnson Ave., El Cajon, CA 92020. Tel: 619-444-2434 fax: 619-444-1987.

**SMD MICRO** inductors. Wire wound on ceramic core. Values from 5 to 90 nhenries tolerances from 5 to 20%. Types 0603, 0805, 1008 SMD. Bulk and reel. 40 million open to offers! 760-736-4411.



**AMAZING! 35c ALL TOGGLE SWITCHES.** Brand new. Rated 6A/125V. Hardware included. 1/4" panel hole. SPDT or DPDT on-on, or on-off-on. Minimum 100pcs./package. Add \$6 freight. Gateway Products Corporation, PO Box 936397, Margate, FL 33093, 954-974-6864, Fax: 954-974-6818, VISA/MC, no COD.



**B/W 430 LINE CCD CAMERA** with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; 9-14 VDC, 0.08 lux, IR sensitive; 1.27" x 1.27" x 0.5"D pinhole or 1" deep standard. Price @ 10 pcs., \$44 each. Enclosure: \$8; optional lens: \$18. Dealers welcome. MATCO, Inc. 1-800-719-9605. Fax 847-619-0852. E-Mail: sales@mat-co.com Website: www.mat-co.com

## MICROCONTROLLERS

**68HC11, 80C552 and 8031** microcontroller boards. Uploader, assembler and compiler software included. See our products at: www.tecel.com

**WIN \$500 USD** cash donronics.com

**Don't miss a single issue!** Have Nuts & Volts delivered right to your door every month for only \$19 per year. Call 1-800-783-4624



**PIC MICROCONTROLLER PROGRAMMER KIT.** Super value at \$19.95 + \$4.95 shipping. See our web site for the complete range of PICs that can be programmed. Includes PCB, parts and instructions. P16PRO shareware must be downloaded from the web. Amazon Electronics, tel 1-888-549-3749. Lots of other products. [www.electronics123.com](http://www.electronics123.com)



### THE CAKEPAN RECEIVER KIT 2 TUBES GENERAL COVERAGE REGEN

- Receives Am, SSB, and CW
- Regenerative Receiver Design
- Uses two 6AQ5 Tubes
- Continuous coverage 500 KC - 10MHz using pre-wound plug in coils as in old fashioned regenerative receivers (Coils sold below)
- Smooth Vernier Dial Tuning (No Logging Scale)
- J fel front end isolates the antenna and adds RF gain.
- Solid frequency stability.
- Ultra sensitive reception.
- Hi Fi quality audio into 8 ohms. Enough to drive a small speaker (not included)
- Headphone Jack.
- Audio clipper circuit eliminates key clicks and heavy static.
- Solid state power supply.
- Complete punched and drilled chassis (tuning caps and solder lugs are pre-installed)
- Well written detailed assembly instructions include color pictorials. Manual included.
- Assembly time approx. 6 hours
- Measures 9" Wide x 9" Deep x 2" High • Weight approx. 5 lbs.

ASSEMBLE A COMPLETE QRP STATION. THE CAKEPAN RECEIVER MATES PERFECTLY WITH OUR CPCW-5 TUBE TRANSMITTER

Part No.	Description	Price
CPR-1	2 Tube Receiver Kit	\$119.95
CPR-B	Broadcast Band Coil 500KHz-1800KHz	\$14.95
CPR-160	160 Meter Coil 1.5 MHz-3.0MHz	\$9.95
CPR-80	80 Meter Coil 2.9MHz-7.5MHz	\$9.95
CPR-40	40 Meter Coil 4.00MHz-10MHz	\$7.75

### DIGITAL LCR METER — ALSO MEASURES VOLTS, AMPS & FREQUENCY

At Last! An LCR meter that everyone can afford. Now you can measure coils, transformers, chokes from 1µH to 40H. Capacitors from 1 pfd to 400 mfd and resistors from 1 ohm to 40 meg ohms. DCV to 1000 V, ACV to 750V Freq. 1Hz to 4MHz. Great price for this instrument.

**LCM-1950 ..... \$79.95**

### VARIABLE CAPACITORS BROADCAST TYPE — 1/4" SHAFT

1 GANG 14-365PF	\$10.95
2 GANG 10-400/10-400/PF	19.95
3 GANG 15-500PF/SEC	12.95

Many more types available from small air trimmers to large 4KV tuner types.

### 6146W POWER TUBE

Rugged version of popular 6146B used in many transmitters. MFG. GE

**\$17.95 EA. or \$37.00 MP**

**12BY7A Driver ..... \$15.95**

CALL US FOR ALL YOUR TUBE NEEDS.

### LEARN COMPUTER THEORY BY BUILDING THIS KIT

#### DIGITAL TRAINER MODEL MM-8000

Starting from scratch you build a complete computer system. Our Micro-Master trainer teaches you to write into RAMs, ROMs and run a 8085 micro-processor. You will write the initial instructions to tell the 8085 processor to get started and store these instructions in permanent memory in a 2816 EPROM. Teaches you all about input and output ports, computer timers. Build your own keyboard and learn how to scan keyboard and display. No previous computer knowledge required. Simple easy to understand instruction teaches you to write in machine language. Upon completion of this course you will be proficient in computer technology.

- Uses the 8085 Microprocessor
- Uses the 2816 EPROM, electrically erasable programmable ROM
- Uses the 8156C, 2048 Bit static MOS RAM with I/O ports and timer
- Memory expandable option
- Built in 5V power supply
- 28 key keyboard
- Complete with lesson manual, instructions and experiments.

**All this for only ..... \$79.95**

## OCEAN STATE ELECTRONICS

CALL, WRITE OR FAX FOR OUR FREE 104 PAGE CATALOG 1-800-866-6626

Step back into the past and build a Vintage tube type receiver or transmitter. Each kit comes with all the necessary components to get you on the air vintage radio style. A great opportunity to learn to build, troubleshoot and operate vintage tube type equipment.

## ANTIQUE ELECTRONICS

**WANTED: FOR** historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

**CRYSTAL SETS.** Parts, plans, books, kits. Largest source in the world. Catalog \$2. MIDCO, PO Box 222288, Hollywood, FL 33022.

**WANTED: STOCK TICKERS, WESTERN UNION, EDISON, WITH OR WITHOUT GLASS DOMES, 217-345-6771.**

**RADIO TUBES** and phono. needles. 870-347-2281.

**ANTIQUE ELECTRONICS:** Wanted RCA 45RPM record changer with amplifier and schematic, in working order. 504-834-5010.

## AVIATION ELECTRONICS

**BUY, SELL, trade,** avionics equipment, Collins, King, Sperry: test equipment, IFR, Litton LTN series INUs. 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.nets

### QRP CW TRANSMITTER KIT 2 TUBES, 3 BANDS



- 3 Band CW Coverage — 160, 80, 40, meters using prewound plug in coils (sold below)
- Crystal Control
- 5 Watts Output into 50 OHMS
- Single Antenna operation with built in TR Switch
- LED Output Power Indicator
- Cathode Keying Circuit
- Solid State Power Supply
- Tube Line Up 6CA Crystal OSC, 6AQ5 Final
- Complete with Pre Wound 80 Meter Coil Included
- Complete Instruction and Color Pictorials
- Use with any Receiver or Transceiver
- Includes 2 Crystals for 80 Meters — 3.64MHz & 3.70MHz
- Complete Punched and Drilled Chassis
- Measures 9"W x 9"D. Weight approx. 5 lbs.
- Assembly time approx. 6 hours

BE UNIQUE! GO QRP VINTAGE RADIO STYLE!

Part No.	Description	Price
CPCW-5	2 Tube Transmitter	\$109.95
CPC-160	160 Meter Coil	\$9.95
CPC-80	80 Meter Coil (included)	\$9.95
CPC-40	40 Meter Coil	\$9.95
CY1812	160 Meter Crystal 1.812MHz	\$9.65
CY3560	80 Meter Crystal 3.560MHz	\$9.65
CY7040	40 Meter Crystal 7.040MHz	\$9.65

OTHER CRYSTAL FREQUENCIES IN STOCK. PLEASE INQUIRE.

### DELUX CODE KEY



Adjustable, heavy duty brass base with ball bearing pivots. Designed for hard usage. 3/16" plated contacts.

**\$16.95**

### CODE PRACTICE OSCILLATOR & MONITOR



3" Speaker, Headphone Terminal, Volume & Tone Controls. Uses 1 9V Battery

Kit ..... \$19.95

Wired ..... \$24.95

### SIGNAL INJECTOR/ TRACER

This handy tester is both a signal generator and receiver. As a generator use it to check out an amplifier, stage by stage. Also tests AM radio IF and RF stages. As a receiver you can pin point where a defective part exists. Will transmit and receive simultaneously.



Kit ..... \$18.95

Assembled ..... \$24.95

### NEW! PCDATA™ SOFTWARE FOR MAKING PRINTED CIRCUIT BOARDS ON ANY WINDOWS 95 OR MS-DOS IBM COMPATIBLE PC!

- Make single or double sided PC Board artwork, up to 30" x 30".
- Print your artwork on any PostScript™ Laser Printer.
- Produces a 1X positive, ready to use with pre-coated board. No other artwork required.
- Produce industry standard solder mask and component layout for silkscreen art.

PCDATA™ is supplied on one 3.5" diskette with a quick start manual. The full user's manual is larger and must be printed by the user (dot matrix printer ok); approximately 75 pages in length.

The **NEW PCDATA™** software lets you create PC boards ranging from prototypes to hobby projects, and on a par with the pro's. You may do the complete printed circuit board layout artwork on your own PC, at a fraction of the cost of other programs. Print the layout on any PostScript™ compatible printer, either on regular paper to be photographed for a positive or negative, or on clear film to be used directly as a positive with other Datsak products.

**ALL THIS FOR ONLY ..... \$29.95**

**TO ORDER CALL  
1-800-866-6626**

**Ocean State Electronics**

P.O. Box 1458 6 Industrial Drive  
Westerly, RI 02891  
Phone: 401-596-3080 Fax: 401-596-3590

Mail in orders please include \$5.00 shipping.

CANADA \$10.50 OVERSEAS \$16.00

Minimum order \$10.00 (before shipping)

R.I. Residents add 7% Sales Tax

VISA & MASTERCARD ACCEPTED



### VERNIER DIALS

1-1/2" Diameter 0-10 Marking ..... \$11.95  
1-1/2" Diameter 0-100 Marking ..... \$12.95  
2" Diameter 0-100 Marking ..... \$13.25



### VERNIER DRIVE

American made 6.1 vernier drive. Has dual plate mounting flange with two tapped holes (2-56) for dial mounting. Input & output mate with 1/4" shaft.

**\$9.95**



### SIGNETICS NE602AN

Balanced Mixer/OSC. Popular IC among experimenters for building DC and super-het receivers.

**\$2.49**



### MINI-CIRCUITS SBL-1 DIODE RING MIXER

Double Balance Mixer  
LO/RF — 1-500 MHz  
RF DC — 500 MHz

**\$7.95**

OTHER MINI-CIRCUIT PRODUCTS IN STOCK

### AM RADIO RECEIVER on a CHIP (TYPE ZN414)

In a tiny (TO-92) transistor size case, a ten transistor tuned RF circuit that requires no setup or alignment. Nearly a complete circuit, add battery (1.1 to 1.6 volts), tuning coil and capacitor and crystal earphone. Data sheets with circuit examples included.

**ZN414 ..... \$7.95**

### FERRITE "LOOP-STIK" ANTENNA

Hard to find Loop-Stik Antenna. NOW IN STOCK! For radio receivers. Tunes the broadcast band. 540KHz-1600KHz.

Measures 1/2" Dia. x 3 1/2" Long. Includes mounting bracket. Q=25, L=788µH.

**LA-540 ..... \$2.25**

### PLUG IN COIL FORMS

Wind your own coils with these plug in coil forms. Made from Grade XX Phenolic. Equipped with rim, making it easy to insert and pull out. Coils measure 1 1/4" Dia. by 2 1/4" H. Exclusive of the pins. These are like the coil forms used in all the early receivers and transmitters. Hard to find item. Will mount in a 4.5 or 6 pin tube socket.

PART NO.	PINS	PRICE
CF-4	4	\$6.90
CF-5	5	\$6.90
CF-6	6	\$6.90

### MAGNET WIRE

Enamel coated solid copper. For winding coils, transformers and toroids. Prices for 1/4 lb. spools.

#14 ..... \$4.00	#24 ..... \$4.25	#34 ..... \$6.25
#16 ..... 4.00	#26 ..... 4.25	#36 ..... 6.45
#18 ..... 4.00	#28 ..... 4.85	#38 ..... 6.95
#20 ..... 4.00	#30 ..... 4.85	#40 ..... 7.85
#22 ..... 4.25	#32 ..... 4.85	

### TOROIDS

IRON	FERRITE
T-25-2 ..... \$ 40	FT37-43 ..... \$ 70
T-25-6 ..... 50	FT37-61 ..... 70
T-37-2 ..... 55	FT37-77 ..... 70
T-37-6 ..... 55	FT50-43 ..... 85
T-50-2 ..... 65	FT50-61 ..... 85
T-50-3 ..... 65	FT50-77 ..... 85
T50-6 ..... 65	FT82-43 ..... 1.30
T68-0 ..... 90	FT82-67 ..... 1.30
T68-2 ..... 90	FT82-68 ..... 1.30
T68-6 ..... 90	FT114-61 ..... 2.30
T80-2 ..... 1.20	FT140-43 ..... 3.50
T200-2 ..... 6.00	FT240-61 ..... 8.75

WE STOCK A COMPLETE LINE OF TOROIDS AND BEADS.

### FM RADIO IC TDA 7000

Ideal for small mono FM receivers. Features an RF input stage, mixer LO, IF amp/limiter stage, phase demodulator and muting circuitry. Also useful in LAN, data and SCA receivers. Data Sheet Included.

**TDA7000 ..... \$9.95**



# C and H SALES COMPANY

2176 E. Colorado Blvd. • Pasadena, CA 91107

**TOLL FREE:**  
**1-800-325-9465**

....  
**FREE**  
**148 PAGE**  
**CATALOG!**  
....

C & H SALES COMPANY HAS BEEN IN BUSINESS FOR OVER FIFTY YEARS.  
WE'RE THE BEST SOURCE FOR GREAT BUYS ON ITEMS LIKE THESE - AND MORE!

## ELECTRONIC COUNTER

HEWLETT PACKARD,  
Model 5328A. Universal  
counter. Usable to 100  
MHz, 100 ns single shot resolu-  
tion. Has frequency, period, period average, ratio, total-  
ize, scale functions. A built-in digital voltmeter allows  
measurements of input voltages. Two input channels  
provide individual slope, polarity and level settings. Has  
9 digit LED readout. Input power 100-240 VAC 48-66  
Hz 100 VA max. Dimensions: 17" wide x 17-1/4" deep x  
3-1/2" high.

Stock #TE9808

\$250.00



## MILLIOHMETER

HEWLETT PACKARD,  
Model 4328A.  
Designed to measure  
very low resistances.  
Measurement range  
1m ohm to 100 ohms.  
Resolution 20 u ohms.  
Analog meter readout. Ideal for  
measuring contact resistance of switches or relays. This  
unit is also useful for measuring the resistivity of semi-  
conductor devices. (Requires special 4 terminal probes  
which are not supplied, but probably are available from  
Hewlett Packard.) Power input: 115-230 VAC 48-66 Hz,  
5 VA max. Dimensions: 5-1/8" wide x 11-1/2" deep x  
6-1/2" high.

Stock #TE9812

\$200.00



## ALTIMETER/BAROMETER

KOLLSMAN, #MC-2  
MS28074-2.  
Scale type altimeter  
with baromet-  
ric setting scale  
window. Altimeter  
scale range  
-1000 to 80,000  
feet. Barometric  
range 28.1 to  
31.0 inch of mercury. An adjustment knob is provided for  
scale setting to local altitude or barometric pressure. Has  
white numerals on a black background. Illumination is  
provided. Electrical input is rated 115 VAC 400 cycles.  
Pressure input port is female 7/16" X20 thread. Standard  
aircraft panel 3-1/8" mount. Dimensions: 2-1/4" sq. x  
7-1/2" deep.

Stock #STOCK #IN9900

\$79.50

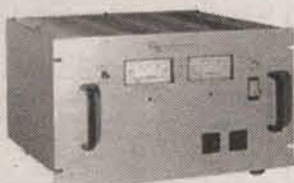


## SOLA CONSTANT VOLTAGE TRANSFORMER

SOLA ELECTRIC, #93-13-150. Harmonically neutralized  
constant voltage transformer. Rated at 500 watts. Input  
voltage 95 to 130 VAC 60 Hz. Output voltage 120 VAC.  
This unit is designed for rack or bench mounting. The  
meters on the front panel indicate output current and  
input/output voltage. A toggle switch is provided for  
selection of input or output voltage. The input voltage is  
connected at the rear of the unit via a covered electrical  
panel. Two standard 3-wire grounded electrical outputs  
are supplied on the front and rear panels. Dimensions:  
19" wide x 14-1/4" high x 10-1/4" deep. Weight 59 lbs.

Stock #STR9900

\$225.00



☒ Master Charge ☒ Visa ☒ American Express ☒ Discover

Call us first if you have surplus inventories of electronic, optical, or mechanical items for disposal

**WE BUY & SELL!**

Write in 81 on Reader Service Card.

## Lowest Dealer Price Available

	5+	10+	20+
Refurb. Panasonic 145	\$45	\$40	\$35
Regal w/Remote	\$38	\$35	\$30
BC4535 86 Channel	\$30	\$28	\$25
Oak Sigma 99 Channel	\$45	\$40	\$35
75 Channel Converter	\$18	\$18	\$18
Zenith ST1600 w/Remote	\$75	\$70	\$65

Panasonic Converters Model-175 \$65 \$55 \$45  
(550MHz) Six month's warranty on this model only

Call us today to satisfy all your cable equipment needs!

**SAM'S ELECTRONICS**  
**1-405-631-1856**

All Cable Equipment is unmodified.

## PUBLICATIONS

WEBBOOKS OFFERS discount prices  
on technical/engineering books plus free  
assistance to authors. Please visit us at  
<http://webbooks.net>

## ROBOTICS

ROBOT BOOKS.COM visit our web site  
for reviews of robotics books, plus robot  
kits, toys, movies, and magazines!  
[www.robotbooks.com](http://www.robotbooks.com)

ARobot KIT from Arrick Robotics uses  
the BASIC Stamp II. Quality metal con-  
struction. Easy to assemble and very  
expandable. \$235. <http://www.robotics.com/arobot>

H-BRIDGE MOTOR controllers, 12VDC,  
35A average, 50A peak PWM out.  
Forward, reverse, ramp-up and ramp-  
down on acceleration/deceleration.  
Current foldback when hot, reverse  
polarity protected, conformal coated,  
regenerative braking, compact, approx.  
3.75"x5.5". \$25 & S&H. 570-735-5053.  
<http://members.tripod.com/~divelec>

68HC11, 80C552 and 8031 microcon-  
troller boards. Uploader, assembler and  
compiler software included. See our  
products at: [www.tecel.com](http://www.tecel.com)

GET STARTED in robotics with an  
ARBE-ONE kit (the "Model T" of mobile  
bases), a TCOMP tiny computer  
(68HC11 controller on a board optimized  
for robotics). On-line ordering:  
<http://www.BecTec.com>

www.futurerobots.com ROBOTS are  
coming soon to our homes. Most of the  
technology is now here, as well as the  
need. Read technical papers and con-  
struction articles for active security sys-  
tems.

ROBOTS WANTED: Dead or alive,  
whole or parts. Marvin (Iowa Precision),  
Gemini, RoPet, Hubot, RB5X, Newton  
SynPet, ComroTot, ELAMI, ITSABOX,  
HeathKit (HERO JR, 1, 2000, or Arm  
Trainer), Androbots (TOPO, BOB, Fred,  
and Androman), Rhino, Maxx Steele,  
Omibots, etc. Also looking for robot pro-  
totypes, options, and literature, will pay  
cash. Please E-Mail  
[rdoerr@bizserve.com](mailto:rdoerr@bizserve.com) Call 810-777-1313  
or write to: Robert Doerr, 26308  
Cubberness, St. Clair Shores, MI 48081.

## PLANS — KITS — SCHEMATICS

BUILD THE MENDOCINO MOTOR. This  
fascinating device is a solar powered,  
magnetically levitated motor. It will  
delight and amaze you and your friends.  
The 27 page plans book includes a list of  
parts suppliers. The motor uses readily  
available parts. Plans are \$15 plus \$2.50  
S&H. Write to: St. Elmo's Fire, PO Box  
141, Stow, MA 01775. E-Mail: [tcv@genrad.com](mailto:tcv@genrad.com)

## Use your PC as a scope and datalogger!

### Parallel Port Scope

spectrum analyzer, and digital multimeter

### Environmental Logging

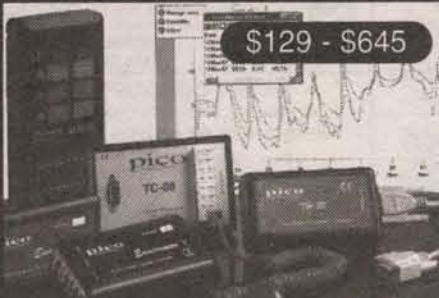
record temperature, humidity, etc.

### osziFOX

20MS/s handheld scope



\$79 - \$799



\$129 - \$645



\$129

ADC Virtual Instruments turn your PC or laptop  
into a sophisticated storage scope AND spectrum  
analyzer AND multimeter. Display simultaneously  
on large screen! 100MS/s 8-bit or 1.2MS/s 12-bit or  
333KS/s versions. Great for schools, test depts, etc.  
Input to Excell LabView/NT drivers included.

ENVIROMON - temperature (thermistor),  
humidity & light sensors, door position, etc.  
Record for 365/24 without a PC even if power  
fails. Monitor 30 sensors 400 yds away. With  
cables and easy software. Remote audio  
alarm. Use TC-08 for most thermocouples.

osziFOX - handheld storage  
scope and DVM - stand-  
alone or plugs into your PC  
for display, store-to-disk,  
printing in color. Inputs to  
100V, trigger, backlit LCD.

Download FREE demo software. Sales only: 1-888-7SAELIG

[www.saelig.com](http://www.saelig.com) 716-425-3753 • -3835 (fax) [saelig@aol.com](mailto:saelig@aol.com)

**pico**  
Technology Limited

Stocked in NY by Saelig Company: Virtual Instruments, I2C and embedded controllers, BITlink 2-wire  
networks, RS232/422/485, frame grabbers, etc. See [www.saelig.com](http://www.saelig.com) for Product of the Month!

PC-based Instruments!



**HOVERBOARDS, JETPACKS, LIGHT-SABERS.** Plans, schematics, and kits for over 100 incredible devices. \$3 for catalog. Future Horizons, PO Box 125, Marquette, MI 49855. [www.futurehorizons.net](http://www.futurehorizons.net)

## PCB Milling

**CIRCUIT BOARDS.** Low-cost, precision-made PC boards from your CAD program files (no photoplots required). Single and double-sided with contour routing. Ideal for RF/analog/digital prototypes. Full details at <http://www.pcbmilling.com>. E-Mail: [feedback@pcbmilling.com](mailto:feedback@pcbmilling.com) FAX: 703-818-0071.



**TERRIFIC TIMEPIECES!** LED binary clock. LED digital clocks, other kits! Free catalog! WPC, 805-339-0702. [www.west.net/~wpc](http://www.west.net/~wpc)

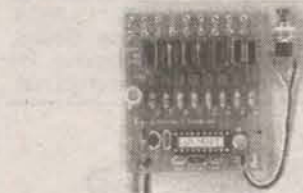


**BROADCAST FARTHER!** 75-110MHz amplifier connects to stereo transmitters. Produces 2-15 watts. Requires 50-150mW drive. Complete plans with part source and antenna information only \$14 + \$2 S&H. **Progressive Concepts**, PO Box 586, Streamwood, IL 60107. 630-736-9822.

**200+ ELECTRONICS PROJECTS.** Build for pleasure or make 100% (or more) profits reselling printed plans. \$1 (refundable) for catalog & dealer info. MATCO-A5, PO Box 509, ROSEVILLE, MI 48066-0509.



**ELECTRIC POWER METER STOPPER** MAKES METER RUN SLOWER, STOP, OR EVEN REVERSE! COMPLETE PLANS \$10, SOLD FOR EDUCATIONAL PURPOSES ONLY. (VISA/MC/AMEX/COD) OPEN 24 HOURS! 352-429-5496 **BRINKER ENGINEERING LABS, USA.**



**RUNNING LIGHTS KIT.** Ideal for Christmas decorations etc. 8 LEDs switch on in 10 push button selectable patterns. 8 speed levels for a total of 80 combinations. Includes PCB, parts and instructions. \$15.95 + \$4.95 shipping. Can operate light bulbs with 8x TRIACs (\$6 extra). Amazon Electronics Tel 1-888-549-3749. Lots of other products. [www.electronics123.com](http://www.electronics123.com)

**AWESOME KITS:** voice changers, levitators, lasers, solar robots, and more! Catalog \$1. **LNS Technologies**, PO Box 67243, Scotts Valley, CA 95067. [www.ncal.verio.com/~lnstech](http://www.ncal.verio.com/~lnstech)

**NEED LARGE,** precision wound coils for vehicle detectors, alarms, loop antennas, proximity detectors, metal locators, direction finders, security gates or other projects? We also sell tubes and AM radio signal boosters which improve reception. Send \$2 for details (refundable with purchase). Fala Electronics-V, POB 1376, Milwaukee, WI 53201.

**UNLIMITED UNDERGROUND ELECTRONICS.** Electronic weapons, EMP, high voltage, rail & coil guns, plasma, alternative energy, surveillance, ETC. UUE: 1839-D West Vista Way #515, Vista, CA 92083. Visit us at: <http://www.access1.net/nintech> or E-Mail: [nintech@access1.net](mailto:nintech@access1.net). SASE for free catalog.

## World's Smallest TV Transmitters

We call them the 'Cubes'... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies - that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air!



C-2000, Basic Video Transmitter Cube.....\$89.95  
C-3000, Basic Video & Audio Transmitter Cube.....\$149.95  
C-2001, High Power Video Transmitter Cube.....\$179.95  
C-3001, High Power Video & Audio Transmitter Cube.....\$229.95

## CCD Video Cameras

Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infrared) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80°) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for audio sound pick-up and super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens.....\$69.95  
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens.....\$69.95  
CCDCC-1, Color CCD Camera, wide-angle lens.....\$129.95  
IR-1, IR Illuminator Kit for B&W cameras.....\$24.95  
IB-1, Interface Board Kit.....\$14.95

## Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast which has handy SCA output. Add our snazzy matching case and knob set for that smart finished look.

AR-1, Airband 108-136 MHz Kit.....\$29.95  
HFRC-1, WWV 10 MHz (crystal controlled) Kit.....\$34.95  
FR-1, FM Broadcast Band 88-108 MHz Kit.....\$24.95  
FR-6, 6 Meter FM Ham Band Kit.....\$34.95  
FR-10, 10 Meter FM Ham Band Kit.....\$34.95  
FR-146, 2 Meter FM Ham Band Kit.....\$34.95  
FR-220, 220 MHz FM Ham Band Kit.....\$34.95  
SR-1, Shortwave 4-11 MHz Band Kit.....\$29.95  
Matching Case Set (specify for which kit).....\$14.95

## Tiny FM Transmitters



Gosh, these babies are tiny - that's a quarter in the picture! Choose the unit that's best for you. FM-5 is the smallest tunable FM transmitter in the world, picks up a whisper 10' away and transmits up to 300'. Runs on tiny included watch battery, uses SMT parts. FM-4 is larger, more powerful, runs on 5-12 volts, goes up to a mile. FM4.5 operate in standard FM band 88-108 MHz. FM-6 is crystal controlled in 2 meter ham band, 146.535 MHz, easily picked up on scanner or 2 meter rig, runs on 2 included watch batteries. SMT (surface mount) kits include extra parts in case you sneeze & lose a part!

FM-4MC, High Power FM Transmitter Kit.....\$17.95  
FM-5, World's Smallest FM Transmitter Kit.....\$19.95  
FM-6, Crystal Controlled 2M FM Transmitter Kit.....\$39.95  
FM-6, Fully Wired & Tested 2M FM Transmitter.....\$69.95

**VOICE CHANGER:** PCB with all board mounted components plus speaker. (Watch for our N&V article.) New price \$9.95 postpaid in US. MicroMethods, PO Box 909, Warrenton, OR 97146. 503-861-1765 [jdennon@seasurf.com](mailto:jdennon@seasurf.com)

**LEARN HOW to:** Descramble cable television, listen to phone calls, and make your computer 40% faster! On the web: <http://www.cyberweb.org/adamsghettomart/>

**PIC INSTRUMENTATION** and monitor chips, quick protoboards, kits, telephone electronics, pocket testbench, Oricom Technologies, 303-449-6428, [www.sni.net/~oricom](http://www.sni.net/~oricom)

## Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Pro FM Stereo Transmitter Kit.....\$249.95  
FM-100WT, Fully Wired High Power FM-100.....\$399.95

## FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Excellent audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit.....\$129.95

Lower cost alternative to our high performance transmitters. Great value, tunable over FM band, plenty of power and manual goes into great detail about antennas, range and FCC rules. Handy kit for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit.....\$34.95  
CFM, Matching Case and Antenna Set.....\$14.95  
FMAC, 12 Volt DC Wall Plug Adapter.....\$9.95

## RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set.

LPA-1, Power Booster Amplifier Kit.....\$39.95  
CLPA, Matching Case Set for LPA-1 Kit.....\$14.95  
LPA-1WT, Fully Wired LPA-1 with Case.....\$99.95

## FM Station Broadcast Antenna

For maximum performance, a good antenna is needed. Properly tuned and matched antenna is fully PVC enclosed for weather protection and rugged use. Vertical or horizontal mounting, 'F' style connector, 5' long.

TM-100, Tru-Match FM Station Antenna Kit.....\$39.95

## AM Radio Transmitter

Operates in standard AM broadcast band, set to clear channel in your area. AM-25 'pro' version is synthesized for stable, no-drift frequency and is settable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 has tunable transmit oscillator, runs FCC maximum 100 mw power, expected range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set for a finished, professional look. High level modulation for low distortion.

AM-25, Professional AM Transmitter Kit.....\$129.95  
AM-1, Entry level AM Radio Transmitter Kit.....\$29.95  
CAM, Matching Case Set for AM-1.....\$14.95

**X-10 CONTROLLER** with easy interface to controllers or processors and SPI networks. Includes keypad interface that optionally emulates standard X-10 tabletop units. Get the SPI-X10 PCB (kit or complete & tested) or chip only. Plugs directly into the ModCon HC11 controller with sample programs. Build your own home automation system! <http://ZORINco.com> 206-282-6061.

**HEATHKIT COMPANY** is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: 616-925-5899, 8-4 ET.

**CIRCUIT BOARDS** made from your artwork. Quick turn, low rates. Atlas Circuits, PO Box 892, Lincolnton, NC 28092. 704-735-3943.

## RAMSEY Binocular Special

Wow, did we nab a deal on these first rate binoculars! Absolutely identical to a famous big name brand here in Rochester, NY - but without 'their' name. Well made with fully coated optics, super nice rubber armored housing over hi-alloy aluminum, includes lens cleaner cloth, neck lanyard and carry case. 4 styles: roof prism 10x25 (10 power, 25 mm), 10x25 high performance roof prism ruby coated objective lens model for demanding use in bright sun, 10x25 high-end BAK-4 lens porro prism ruby coat with Tac-Grip housing, and Ultra-View 10x50 porro prism ruby coats. First quality, yet at a close-out price on the exact same units as the 'Trademarked' units - but at half price!

BNO-M, 8x21 Mini Monocular.....\$14.95  
BNO-1, 10x25 Roof Prism Binoculars.....\$24.95  
BNO-1EX, 10x25 Ruby Coated Porro Prism.....\$29.95  
BNO-2, 10x25 TacGrip Ruby Coat Porro Prism.....\$59.95  
BNO-6, 10x50 Ultra-View Ruby Coat Porro Prism.....\$69.95

## World's Smallest FM Radios

Everyone who sees one of these babies says they just gotta have one! Super cute tiny FM radios have automatic scan/search tuning, comfortable ear bud earphones and we even include the battery. The pager style unit looks like a shrunken pager and even has an LCD clock built-in. You will be amazed at the crystal clear amazing sound! That's a quarter in the picture for size comparison - pretty tiny, huh?

MFMT-1, World's Smallest FM Radio.....\$11.95  
PFMR-1, Pager Style LCD Clock & FM Radio.....\$12.95

## Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit.....\$39.95  
CSS, Custom Matching Case and Knob Set.....\$14.95  
SS-70AWT, Fully Wired SS-70A with Case.....\$79.95  
AC12-5, 12 Volt DC Wall Plug Adapter.....\$9.95

## Call for our Free Catalog!

See our complete catalog and order on-line with our secure server at: [www.ramseyelectronics.com](http://www.ramseyelectronics.com)

**RAMSEY ELECTRONICS, INC.**

793 Canning Parkway Victor, NY 14564

**Order Toll-free: 800-446-2295**

Sorry, no tech info, or order status at this number

**For Technical Info, Order Status Call Factory direct: 716-924-4560**

**VISA MasterCard AMERICAN EXPRESS DISCOVER**

**ORDERING INFO:** Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add \$6.95 for shipping, handling and insurance. Orders under \$20, add \$3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.



## MISCELLANEOUS ELECTRONICS FOR SALE

NEW, USED, and "as is" Radio Shack items. Software, printers, computers, books, parts for R/C cars, etc. Free list. B and B Enterprises, 208 S. Pulaski St., Baltimore, MD 21223. 410-566-5388.

**ELECTRONIC PARTS: LOW, LOW PRICES!** Phone, fax, E-Mail for free flyer. Hoffman Industries, 853 Dundee Ave., Elgin, IL 60120. Ph: 847-622-8201, Fax: 847-622-8202, E-Mail: hoffind@aol.com Web site: <http://hoffind.com>

**DESOLDER STATIONS: OWN PUMP:** Weller DS1000 w/readout \$350, Ungar 4024 \$200, PACE MBT201, MBT210, MBT220, MBT250, PRC2000 bases only or complete with handpieces call for prices. **HOT TWEEZER** pulls SMD parts \$75. **SOLDER STATIONS:** Weller: EC2000 digital readout \$100, WTCP \$50, EC2002M \$225 new, EC1301, 1302 pencils \$50 new. Desolder handpiece 70 watt 110VAC \$50. 310-515-2058.

**HARD-TO-find parts:** big screen tubes \$135; 13", 19", 25" \$25; electronic tuners \$20; RF modulators \$5; modules, knobs, flybacks. Call 912-272-6561. Scarborough TV, 1422 Old River Rd., East Dublin, GA 31027.

**CALL FOR a free electronics catalog** or visit our web site at [www.bgmicro.com](http://www.bgmicro.com)/ B.G. Micro, PO Box 280298, Dallas, TX 75228. Order line 1-800-276-2206.

**NUCLEAR ELECTRONICS** (NIM, CAMAC), PMTs, optics, high vacuum, and high voltage components and equipment. Guaranteed quality at reasonable cost. OE Technologies, Box 703, La Madera, NM 87539. Ph: 505-583-2482, Fax: 505-583-9190, E-Mail: oetech@newmexico.com <http://www.oetech.com>

**FREE FLYER** on DBS, cable TV, phones, credit cards, schematics, health items. Bill 1-800-879-9657.

**LEARN HOW to:** Descramble cable television, listen to phone calls, and make your computer 40% faster! On the web: <http://www.cyberweb.org/ad/amsghettomart/>



**ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE** since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors. Wire cut & strip to specs. If interested, please call 1-800-626-7540, FAX: 714-771-5043. Visa/MC/Amex. SEE US ON THE INTERNET: <http://www.aheimwire.com> OR E-Mail: info@aheimwire.com

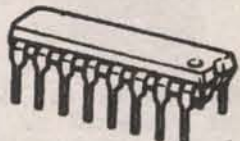
**HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE.** European and American screwdrivers, nut-drivers, pliers, hex-keys, balldrivers, and more! Wiha, Bondhus, and Knipex. Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 732-758-8388. E-Mail: w2tv@csi.com



**SOLAR-POWERED FAN HAT.** Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. \$19 plus \$2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

## MISCELLANEOUS ELECTRONICS WANTED

**HIGHEST PRICES PAID:** I will pay the following prices for Western Electric tubes: 211A/D/E new \$300, used \$175; 212A/D/E new \$750, used \$275; 274A/B (engraved base) new \$250, used \$200; 300B (engraved base) used \$550; 422A new \$50, used \$25; 437A new \$50, used \$25; and many more. Also buying Western Electric, and other audio tube and equipment literature. Call or send us your list. Toll free tel/fax: 1-888-715-8823. Don Singerhouse/Singerhouse Sound, LLC, PO Box 321, New Richmond, WI 54017. E-Mail: singtube@frontiernet.net



**WANTED: EXCESS ELECTRONIC COMPONENTS, BOARD-LEVEL COMPONENTS; ICs, MEMORY, TRANSISTORS, DIODES, CAPS, RELAYS, ETC. CALL LA PALMA SEMICONDUCTOR, 714-523-8892 FAX 714-523-8898.**

**WANTED: AVIONICS** test equipment, IFR, 600A, 401L, others, Collins, King, Sperry, North Atlantic, Litton INUs LTN series, rate and tilt tables, air data test sets, 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.net

# ALL ELECTRONICS

C O R P O R A T I O N

QUALITY  
PARTS

FAST  
SHIPPING

DISCOUNT  
PRICING

CALL, WRITE, FAX  
or E-MAIL For A  
Free 96 Page  
CATALOG.  
Outside the U.S.A.  
send \$3.00 postage.

### MINI-RIGHT ANGLE GEARHEAD MOTOR WITH CIRCUIT CONTROL

Omron # R2DG-41 Built-in control circuits allow this motor to be used in a continuous or a pulsed mode. In continuous mode the final drive gear turns at 22-45 RPM (3-6 Vdc). In the pulsed mode the final drive gear turns one revolution each time the controller is momentarily pulsed. The motor assembly is 1.75" x 1.25" x 0.5" overall. The nylon final gear is 0.62 diameter and has a little nipple slightly off-center to which a small push-rod could be attached. Motors are in good condition, removed from equipment. Hook-up instructions included.

CAT# DCM-110 \$7.50 each  
10 for \$60.00

### ENCLOSED SWITCHING POWER SUPPLY

Voltek Corp # SPEC7188B Input: 100 - 240 Vac Outputs: + 5 Vdc @ 3.70 A, +12 Vdc @ 0.60 A, -5 Vdc @ 0.05 A, +5 Vdc Trickle @ 0.1 A. Metal encased switching supply. Standard three-prong IEC socket power input. 7 conductor, Molex-type connector output. 9" x 2.1" x 1.36". UL recognized. Removed from new equipment.

CAT # PS-27 \$3.50 each

### 3000 MCD ULTRA-BRIGHT RED LED

Everlight # 383URC-2/TR1-C(R) Red, "Ultra-bright" T 1 3/4 LEDs "Tape-and-reel" parts. These are 5 mm diameter water-clear LEDs that light bright red at 20 ma.

CAT# LED-50  
2 for \$1.00 100 for \$35.00  
1000 for \$250.00

### 30 Minute Timer Board

Timer circuit board will operate 120 or 240 Vac devices. Originally designed to run a vibrating motor in a massage chair, the circuit automatically shuts-off a motor, lamp or other device after approximately 30 minutes. Shut-off time can be varied by replacing one of the resistors on the board with a pot or resistor of different value. Hook-up instructions included with the board explain how to make this modification. 1.9" x 2.5". CAT# TMR-5

\$3.50 each

### 45 Amp Solid State Relay

Crouzet/Gordos # G240D45 Control Voltage: 3-32 Vdc Load: 45 Amps, 24-280 Vac Back-to-back (dual) SCR output for severe induction loads. False turn-on immunity and positive turn-off at high dv/dt. Standard "hockey-puck" 2.25" X 1.75" X 0.90". UL/CSA

CAT# SSRLY-45 \$19.50 each

### Surface Mount Momentary Pushbutton Switch

Panasonic # EQV PHV03T S.P.S.T., normally open, surface mount pushbutton. 0.25" square x 0.13" high. Leads on 0.15" centers.

CAT # PB-85 3 for \$1.00

100 for \$25.00 • 2000 per reel \$200.00

### "HI-8" Video Cassette

SONY HI-8 Top quality, metal particle 120 minute video cassettes. Used for a short time, then bulk-erased. Each cassette has its own plastic storage box.

CAT # VCU-8 \$3.00 each

10 for \$28.00 • 100 for \$250.00

ORDER TOLL FREE

1-800-826-5432

MAIL ORDERS TO:  
ALL ELECTRONICS CORP.  
P.O. BOX 567  
VAN NUYS, CA 91408-0567

FAX (818) 781-2653 • INFO (818) 904-0524  
INTERNET <http://www.allcorp.com/>  
E-MAIL [allcorp@allcorp.com](mailto:allcorp@allcorp.com)

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D. • Shipping and Handling \$5.00 for the 48 Continental United States • ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.



# Go Wireless!!!

It's Easy:  
\$9.95 ea.

Antenna input, TTL/CMOS output

TTL/CMOS input, RF output

418 MHz  
433 MHz  
(Actual Size)

Pin 1: Vcc  
Pin 2: Gnd  
Pin 3: Digital In  
Pin 4: Antenna

Pin 1: RF Vcc  
Pin 2, 7: RF Gnd  
Pin 3: Antenna  
Pins 4, 5, 6, 8, 9: NC

Pin 10, 12, 15: Digital Vcc  
Pin 11: Digital Gnd  
Pin 13: Audio testpoint  
Pin 14: Digital Out

**CONVERGENT, INC.**  
1-888-577-7285  
http://www.convergentinc.com/rf  
716 River Crest  
Leander, TX 78641  
Credit Card & COD orders accepted

Write in 84 on Reader Service Card.

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 OR fax 937-847-2350.

**WANTED: BALANCING** machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

**WANTED: TUBE** HiFi/commercial amps, preamps, corner/horn speakers. Alteq, Marantz, McIntosh, Western Electric, etc. 405-737-3312 fax 405-737-3355.

**WANTED: TUBES,** radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Cranbury, NJ 08512-4212. Phone: 609-395-1116, FAX 609-395-1117.

**OLD ICs & TRANSISTORS WANTED:** **HIGHEST PRICES PAID** please FAX your list with part number, quantity & condition of any semiconductors to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! [www.electronicssurplus.com](http://www.electronicssurplus.com)

**WANT USED** or surplus DC motor controls or adjustable frequency AC drives, 1/2 HP and up. DC motors fractional to 3 HP. C. Woodruff, 5507 55th Ave. S., Seattle, WA 98118. Voice/Fax 206-723-8487.

**WANTED: REMOTE** for Pioneer stereo receiver model #VSX504S. 937-599-2997.

**WANTED: X-BAND** radar equipment. Military, civilian, working or not, parts, TMs, etc. Box 10215, Pittsburgh, PA 15232.

**Sell Nuts & Volts in your store!**  
**Contact us for complete details.**  
phone 909-371-8497  
fax 909-371-3052  
E-Mail [distributors@nutsvolts.com](mailto:distributors@nutsvolts.com)

# SURPLUS TEST EQUIPMENT

## HEWLETT PACKARD

11729B, Carrier Noise Test Set	\$3000
11975A, Amplifier, 2-8GHz	\$2000
16500A, Logic Analyzer Mainframe	\$750
3312A, Function Generator, 1Hz-13MHz	\$700
3325A, Synthesizer/Function Generator	\$1000
3325A/01/02, Synthesizer/Function Generator	\$1500
3335A, Frequency Synthesizer, 200Hz-81MHz w/Opt. 01	\$4500
339A, Distortion Analyzer	\$1000
3456A, Digital Multimeter, 6.5 Digits	\$800
3478A, Digital Multimeter	\$700
3488A, Switch Control	\$600
3551A, Transmission Test Set	\$600
35660A, Signal Analyzer	\$5000
3575A, Phase Gain Meter 1Hz-13MHz	\$1000
3577A, Network Analyzer w/35677A Test Set	\$9,500
3580A, Spectrum Analyzer, 5Hz-50KHz, Opt. 2 & 3	\$1000
3581C, Selective Voltmeter	\$800
3585A, Spectrum Analyzer, 20Hz-40.1MHz	\$5500
4192A, LF Impedance Analyzer w/16097A Kit	\$10,000
4342A, Q-Meter	\$1800
435B, Power Meter	\$500
436A, Power Meter w/Opt. 022	\$1000
437B, Power Meter	\$1800
4935A, Transmission Impairment Test Set w/Opt. 003	\$1100
5087A, Distribution Amplifier	\$1000
5318B, Universal Counter	\$1000
5328B, Universal Counter	\$1000
5335A, Frequency Counter, Opt. 10/20	\$850
5340A, Frequency Counter w/Opt. 01/02/011	\$1000
5342A, Microwave Frequency Counter, 10Hz-18GHz	\$900
5355A, Frequency Converter	\$1000
5386A, Frequency Counter, 10Hz-3GHz	\$2000
54100A, Digitizing Oscilloscope	\$1700
54100D, 1GHz Digital Oscilloscope	\$2700
54110D, 1GHz Color Digitizing Oscilloscope	\$2500
54120A, Digitizing Oscilloscope Mainframe	\$5750
54201D, Digitizing Oscilloscope	\$2650
6011A, Autorange Power Supply, 20V/120A, 1000 Watt	\$1200
6012A, DC Power Supply, 0-60V/0-50A, 1000 Watt	\$1200
6034A, DC Power Supply, 0-60V/0-10A, 200 Watt	\$1000
6274B, DC Power Supply, 0-60V, 0-15A	\$1250
6632A, DC Power Supply, 0-20V, 0-5A, 100 Watt	\$1000
778D, Dual Directional Coupler	\$400
8013B, Pulse Generator	\$750
8082A, Dual Pulse Generator, 250MHz	\$1200
8112A, 50MHz Pulse Generator	\$4000
8116A, 50MHz Pulse/Function Generator, Opt. 001	\$4000
8160A, Programmable Pulse Generator, 50MHz	\$2000
8165A/002, Programmable Signal Source w/AM	\$2200
8347A, RF Amplifier, 100KHz-3GHz	\$2500
8350A, Sweep Oscillator Mainframe	\$1000
8350B, Sweep Oscillator Mainframe	\$1500
83522A, Sweeper Plug-in, .01-2.4GHz, w/Opt. 02	\$4000
83540A, RF Plug-in, 2.0-8.4GHz	\$2000
83540A/002, RF Plug-in, 2-8.4GHz	\$2500
83545A, Oscillator Plug-in, 5.9-12.4GHz	\$1750
8411A/018, Frequency Converter, .11 to 18GHz	\$500
8494H, Programmable Attenuator (unused)	\$800
8495H, Programmable Attenuator (unused)	\$600
8501A, Storage Normalizer	\$1000
8505A, Network Analyzer w/8501A & 8503A	\$4000
8510A, Network Analyzer w/Opt. 010	\$7500
8510B, Network Analyzer w/Opt. 010	\$13,000
8554B, RF Spectrum Analyzer Plug-in, 500KHz-1250MHz	\$800
8559A, Spectrum Analyzer Plug-in, .01-21GHz	\$2650
8562A, Spectrum Analyzer, 1KHz-22GHz	\$17,000
8568A/B, Spectrum Analyzer, 100Hz-22GHz	\$16,000
8569B, Spectrum Analyzer, 10MHz-22GHz	\$7000
8640A, Signal Generator, 0.5-512MHz	\$700
8640B, Signal Generator, Opt. 002, .5-1024MHz	\$2100
8640B, Signal Generator, Opt. 1, 2	\$2200
8654A, Signal Generator, 10-520MHz	\$450
8656A, Signal Generator, 100KHz-990MHz	\$1700
8656B, Signal Source, .01-2500MHz	\$2500
8660C, Synth. Signal Generator w/Opt. 1 & 100	\$1000
8660C, Synth. Signal Generator w/Opt. 1/5/100	\$1200
8660D, Synthesized Signal Generator	\$4000
86603A, RF Plug-in, 1-2600MHz	\$800
86603A, RF Plug-in, 1-2600MHz w/Opt. 02	\$950
8663A, Synthesized Signal Gen., 100KHz-2560MHz w/Opt. 001 & 002	\$33,000
8672A, Synth. Signal Gen., 2.0-18.0GHz	\$5000
8748A, S-Parameter Test Set w/Opt. 026	\$1350
8756A, Scalar Network Analyzer	\$1500
8757A, Scalar Network Analyzer, 10MHz-60GHz	\$4000
8901A, Modulation Analyzer w/Opt. 10	\$700
8901A, Modulation Analyzer w/Opt. 02 & 10	\$900

8970A, Noise Figure Meter	\$4500
K382A, Variable Attenuator	\$2300

## TEKTRONIX

1503, TDR Cable Tester w/Opt. 04 Recorder	\$1550
2215, 60MHz Oscilloscope	\$500
2236, 100MHz Oscilloscope	
w/Counter/Timer/DMM	\$1000
2246, 100MHz Oscilloscope	\$1600
2247A, 100MHz Oscilloscope w/Counter/Timer/Volmeter	\$2500
2337, 100MHz Oscilloscope w/DMM	\$1650
2430A, 150MHz Digital Oscilloscope	\$2850
2432A, 300MHz Digital Storage Oscilloscope	\$3000
2445, Four Channel 150MHz Oscilloscope	\$1500
2445A, 150MHz Four Trace Oscilloscope	\$1850
2465, Four Channel 300MHz Oscilloscope	\$2500
2754P, 10KHz-21GHz Spectrum Analyzer	\$8000
465B, 100MHz Oscilloscope	\$450
466, 100MHz Storage Oscilloscope w/DMM44	\$800
475, 200MHz Oscilloscope	\$650
475A, 250MHz Oscilloscope	\$800
576, Curve Tracer	\$2750
577/02, Curve Tracer, Non-storage w/177 Fixture	\$1750
7D20, Programmable Digitizer	\$400
7L5/L3, Spectrum Analyzer, 20Hz-5MHz, w/Opt. 025 Tracking Generator	\$1850
7L12, Spectrum Analyzer, 100KHz-1.8GHz	\$1500

**VISIT OUR WEBPAGE AT  
[WWW.RSSURPLUS.COM](http://WWW.RSSURPLUS.COM)**

7L18, Spectrum Analyzer Plug-in, 1.5-18GHz	
Capable of 60GHz with Mixers	\$2500
7S12, TDR/Sampler	\$450
AFG5101, Arbitrary Function Generator	\$1500
CG5001, Programmable Calibration Generator	\$4000
DSA602, Digitizing Signal Analyzer	\$7500
PG506, Calibration Generator Plug-in	\$600
TM5003, Three Slot Power Mainframe	\$450
TM5006, Six Slot Power Mainframe	\$550

## MISCELLANEOUS

Acme Elect. PS2L1000, Electronic Load	\$850
Datron 1061A, 6.5 Digit Autocal Multimeter, DC Only	\$700
Datron 1062, 6.5 Digit Autocal Multimeter, DC/AC/Ohms	\$900
EIP 545A, Microwave Frequency Counter	\$800
EIP 548A, Frequency Counter, 10Hz-26.5GHz	\$2000
EIP 548B, Frequency Counter, 10Hz-26.5GHz	\$3250
EIP 578, Source Locking Frequency Counter	\$2500
Electro-Metric EMC 11 MK IV, Interface Analyzer, 16Hz-50KHz	\$2000
Electro-Metric EMC 30 MK IV, Interface Analyzer, .1-10KHz-1GHz	\$5000
Electro-Metric NTR-51C, Receiver	\$1250
Fluke 5101B/03, Calibrator	\$3000
Fluke 5200A, AC Voltage Calibrator w/5205A Amp	\$1850
Fluke 8010A, Digital Multimeter	\$175
Fluke 8012A, Digital Multimeter	\$175
Fluke 8050A, Digital Multimeter	\$250
Fluke 8502A, Digital Multimeter, DC Only	\$225
Fluke 8520A, Digital Multimeter	\$350
Fluke 8600A, Digital Multimeter	\$65
Fluke 8810A, Digital Multimeter	\$250
Fluke 8840A, Digital Voltmeter w/Opt. 059	\$600
Gigatronics 910, Frequency Syn., .05-26GHz	\$7000
Keithley 195A, Digital Multimeter	\$700
LeCroy 9424, 350MHz Oscilloscope	\$3500
Marconi 2019A, Signal Gen., 80KHz-1040MHz	\$2200
Polarad 1105E-F, Signal Generator, 0.8-2.4GHz	\$400
Sorensen DCS40-25, DC Power Supply, 40V/25A	\$750
Trans. Devices DLR400 15 3500A, Dynamic Load	\$1500
Trans. Devices DLP 50-60-1000A, Electronic Load	\$800
Trans. Devices DLVP 130-110-1000	
Electronic Load	\$950
Valhalla 2703, AC Voltage Standard	\$2350
Valhalla 4150ATC, Digital Ohmmeter	\$750
W & G DA-30, Protocol Analyzer	\$3000
W & G SNA5, 50Hz-3.2GHz Spectrum Analyzer	\$5000
Wavelek 178, Automatic Synthesizer	\$1700
Wavelek 650, Precision 2MHz Variable Phase Synthesizer	\$1550
Wavelek 2001A, Sweep Generator, 1-1400MHz	\$450
Wavelek 3000-200, Signal Generator	\$900
Wavelek 8003, Precision Scalar Analyzer, 10MHz-40GHz	\$2000
Wavelek 8501, Peak Power Meter	\$2000
Wiltron 560-7550, RF Detector, 10MHz-18.5GHz	\$300
Wiltron 560-7550, RF Detector, 10MHz-26.5GHz, Opt. 2	\$400
Wiltron 560-97550, SWR Autotester, 10MHz-18GHz	\$600

# Weeder Technologies

ON-LINE CATALOG  
[www.weedtech.com](http://www.weedtech.com)

# Pro-Kit

PO Box 2426, Ft. Walton Beach, FL 32549  
Voice/Fax 850-863-5723

### Stackable RS-232 Kits

**Digital I/O** - 12 I/O pins individually configurable for input or output. DIP switch addressable; stack up to 16 modules on same port for 192 I/O points. Turn on/off relays. Sense switch transitions, button presses, 4x4 matrix decoding using auto-debounce and repeat. **\$32**

**Analog Input** - 8 input pins. 12-bit plus sign self-calibrating ADC. Returns results in 1mV steps from 0 to 4095. Software programmable alarm trip-points for each input. DIP switch addressable; stack up to 16 modules on same port for 128 single-ended or 64 differential inputs. **\$49**

**Home Automation (X-10)** - Connects between a TW523 and your serial port. Receive/transmit all X-10 commands with your home-brewed programs. Full collision detection with auto re-transmission. **\$39**

**Caller ID** - Decodes the caller ID data and sends it to your serial port in a pre-formatted ASCII character string. Example: "12/31 08:45 850-863-5723 Weeder, Terry <CR>". Keep a log of all incoming calls. Block out unwanted callers to your BBS or other modem applications. **\$35**

**Touch-Tone Input** - Decodes DTMF tones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation and/or Digital I/O kits using a remote telephone. **\$34**

### Phone Line Transponder

7 individual output pins are controlled with buttons 1-7 on your touch-tone phone. Automatically answers telephone and waits for commands. Monitor room noises with built in mic. "Dial-Out" pin instructs unit to pick up phone and dial user entered number(s). Password protected. **\$49**

### DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Decodes all touch-tones and displays them on a 16 character LCD. Holds the last 240 digits in non-volatile memory. Connect directly to radio receiver's speaker terminals for off-air decoding of repeater codes, or numbers dialed on a radio program. **\$55**

### IR Remote Control Receiver

Learns and responds to the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **\$32**

### Telephone Call Restrictors

Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have "not" been entered into memory. Use touch-tone phone to program.

Block out selected outgoing calls. Bypass at any time using your password. **\$35**

Block out selected incoming calls. Calls identified using Caller ID data. **\$46**



**R & S Surplus**

1050 E. CYPRESS STREET, COVINA, CA 91724

**(626) 967-0846 • FAX (626) 967-1999**







## REFILL INKS FOR INKJET PRINTERS

Refill your old cartridge and save. All refill kits come with instructions and needed materials for refilling inkjet cartridges. Success guaranteed. Available for the following:

**CANON BC-01**, BC-02 CANON BJ10e, APPLE STYLEWRITER, BJ-200 Single Black Refill \$8.00; Triple Refill \$19.00. **CANON BJC-600** (BC-201) Single Black or Single Colors (3 refills) \$8.00. **CANON BJ-130/300/330 & IBM Exec Jet** (Cart #BJI-481 & BJI-642) Black - 3-bottle kit \$22.00. **CANON BJC-210/240** (BC-05 Cart) 3-color kit (3 refills each color for BC-05) \$24.00. **CANON BJC-4000** and Apple Stylewriter 2400 Black 3-bottle kit (3 refills BC-20, 9 refills BCI-21 black, 30 refills BCI-11 black, 10 refills BCI-10) \$19.00. **CANON BJC-4000/BJC70** and Apple Stylewriter 2400 Tri-color kit - 6 refills each color for BCI-21 or 15 refills each color for BCI-11 \$24.00. **CANON BJC-800/820/880** 3-bottle kit (for BJI-643B) \$19.00. **CANON BJC-800/820/880** 3-bottle tri-color kit (Cart #BJI-643CMY) \$24.00. **EPSON STYLUS COLOR PRINTER** - (Cart S020034) Single Triple black \$19.00; Tri-color kit (Cart S020036) 2 refills each color \$24.00. **EPSON STYLUS COLOR II** - (S020047) Triple Black \$19.00 (S020049). Tri-color (2 refills each color) \$24.00. **EPSON STYLUS COLOR 400, 500, & 600** (S020093) Triple black (7 refills total) \$19.00. **EPSON STYLUS COLOR 200, 500** (S020097) Tri-color 3 refills each color \$24.00. **EPSON STYLUS COLOR 400, 600, 800, 1520** Tri-color (S020089) 3 refills each color \$24.00. **EPSON STYLUS 800/1000** (S020025) 3-refill kit, black, \$19.00. **HP DESKJET 500/550/560** (51608A, 51633A, 51626A) Black single refills \$8.00. **HP DESKJET 500/550/560**, Black 3-bottle kit \$19.00. **HP DESKJET 500C/550C/560C**, Tri-color kit (5 refills each color) \$24.00. **HP DESKJET 1200C, DESIGNJET 650** (Cart #HP 51640B) Black Three pack (3 refills) \$19.00. **HP DESKJET 1200C/1600C, DESIGNJET 650** (Cart #HP 51640 C,M,Y). Tri-color kit (one refill each color) \$24.00. **HP DESKJET 600/660** (HP 51629A) Black three pack \$19.00. **HP DESKJET 600C/660C**, (HP 51649A) Tri-color (5 refills each color) \$24.00. **HP DESKJET 855C/1600C** (HP 51645A) Black three pack \$19.00. **HP DESKJET 855C** (HP 51641A) Tri-color kit (2 refills each color) \$24.00. **HP DESKJET 720, 722, 890, OFFICE JET 1170 & 1175** (C1823A) Tri-color kit (2 refills each color) \$24.00. **HP PAINTJET and PAINTJET XL** (51606A) Black 3-bottle kit \$19.00. **HP PAINTJET and PAINTJET XL** (51606C) Tri-color kit \$24.00. **HP PAINTJET XL300** (C1645A & C1656A) Black 3-refill kit \$19.00. **HP PAINTJET XL300** Tri-color kit (1 refill each color) HP 51639C,M,Y \$24.00. **HP THINKJET, QUIETJET, KODAK DICONIX 150** (51604A or 92261A) black 5 refills \$9.00. **IBM/Lexmark/Execjet/4076** (1380620) black 3-refill kit \$19.00. **IBM/Lexmark/Execjet IIC, WinWriter 150 C** (Cart #1380619) 4 refills each color \$24.00. **SNAP AND FILL SYSTEM** - Permits refilling HP 51626A (black for HP 500-series) and HP 51629A (black for HP 600-series) cartridges without making a hole in the cartridge. Consists of special cartridge holder, syringe, plastic tubing, and directions. **STARTER KIT** - with ink for 3 refills \$28.00. **EXTRA INK FOR SNAP & FILL SYSTEM** (black only) 4-oz. bottle \$18.00; 8-oz. bottle \$34.00. Specify whether for HP 51626A or HP 51629A.



## HARD-TO-GET PRINTER RIBBONS

Gorilla Banana, Commodore 1525 \$8.00; Adam Coleco \$12.00; TI-850/855 \$6.00; Centronics 700 Zip Pack \$5.00; C. Itoh Prowriter Jr., Riteman C+/F+ \$6.00; Riteman Inforunner \$8.00; Commodore MPS-801 \$5.00; MPS-803 \$7.00; Decwriter LA30/36 \$4.00; Apple Scribe \$4.00; Mannisman Tally Spirit 80, Commodore 1526 \$5.00; Epson JX-80 4-Color \$14.00; Printronix P-1013 \$11.00; Star SJ144 color 3-pack \$29.00.

ALSO HEAT & TRANSFER RIBBONS AND PAPER FOR PRINTING T-SHIRTS.

Over 300 different ribbons in stock. All ribbons new, not re-inked. Fully guaranteed.

Order directly or send SASE for complete list.

Add \$4.00 per order shipping. California residents add 7.75% sales tax.

On ribbon orders over \$50.00 deduct 10% discount.

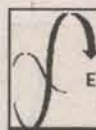
## H.T. ORR Computer Supplies

249 Juanita Way, Placentia, CA 92870-2216

714-528-9822 • 800-377-2023 • FAX 714-993-6216

<http://www.extremeplay.com/occomp/orr.htm>

Write in 85 on Reader Service Card.



Equipment Management Technology

## Moving Sale

Tel 650-631-1700 Fax 650-631-1200 Email sales@emt1.com

### SELECTED SPECIALS!

HP 16505A	\$250	HP E1345A	Make Offer!
HP 16510A	\$100	HP E1347A	Make Offer!
HP 16515A	\$100	HP E1364A	Make Offer!
HP 16516A	\$400	HP E1400B	Make Offer!
HP 3314A	\$1400	HP E1401A	Make Offer!
HP 5335A	\$500	HP E1662A	Make Offer!
HP 59501B	\$250	HP E1671A	Make Offer!
HP 6266A	\$250	HP E1672A	Make Offer!
HP 8016A	\$500	HP E1681A	Make Offer!
HP 83545A	\$3850	HP E1682A	Make Offer!
HP 8493B	\$100	HP E1693A	Make Offer!
HP 8958A	\$5000	HP E1725A	Make Offer!

956 Bransten Road  
San Carlos, CA 94070

**NEW ADDRESS**

We buy, rent, and sell high quality test and measurement products. We occasionally offer great deals on computers as well.

HP OmniBook 600C color subnotebook weighs a mere 3.7lbs for ultimate portability. Special Nuts & Volts price is only \$250!

Dave is test equipment!

Bigdave@emt1.com

Kerry is computers!

kwhite@emt1.com

## BBS & ONLINE SERVICES

**E-MAIL TECH SUPPORT LINE** for TV, VCR, monitor technicians. First 90 days free. For info E-Mail: gregboyd1@juno.com

## EDUCATION

**RF OSCILLATOR DESIGN.** Learn to design RF oscillators from a pro. 90 page course presents the knowhow of oscillator analysis, simulation and design with breadboard experiments. Requires AC/DC and some calculus. \$39+\$6 S&H. **RFLS**, PO Box 9185, Gaithersburg, MD 20898-9185.

**Don't miss a single issue!**

Have Nuts & Volts delivered right to your door every month for only \$19 per year. Call 1-800-783-4624

## BUSINESS OPPORTUNITIES



**COUNTER-SURVEILLANCE=\$250 HR!** Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn \$250 HR in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: 1-800-732-5000.

## REPAIRS - SERVICES

**ENGINEERING CONSULTING.** Product development from conceptual to manufacturing stages. Digital, analog, and RF expertise. Microcontroller designs for HC05xx, HC11xx, and PIC families. Software design for IBM PC. XILINX and Altera FPGA design. In-house schematic capture and PWB. Hicks Electronic Design, PO Box 7366, Loveland, CO 80537-0366. Toll Free 1-888-849-6792 E-Mail: steve@hicksengineering.com website: www.hicksengineering.com

**PINBALL MACHINES!** Books, Magazines, Manuals, Diagrams, Supplies, Parts. \$2 catalog. Marco Specialties, 5290-N Platt Springs Rd., Lexington, SC 29073-9252. 803-957-5500. FAX 803-957-6974. E-Mail: tilt@ix.netcom.com <http://pinballmachine.com>

**(E)EPROM PROGRAMMING** done quickly and economically. One day turn around typical. Simple copy \$3 per device. Also prototyping, design, and consulting services available. Call or send SASE to: **Luzer Electronics, 4023 North Bayberry, Wichita, KS 67226. 316-687-2127, FAX 316-687-3103.**

**PICS, GALS READ** if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

**PC BOARDS REPAIRED.** Prices start at \$5. Minimum 5 of one type. Network Sales, 616-683-0500.

**PCB SERVICES:** Graphic design from schematic, thru hole and SMT. In-house prototype fabrication, assembly, turn key or kit. Small quantity specialist. In business 16 years. Midland Technologies, 34374 E. Frontage Rd., Bozeman, MT 59715. 1-800-726-8871.

# CABLE TV CONVERTERS

WILL NOT DECODE

The Best Prices and Service • In Business over 15 years!

Phone 218-346-6660 Fax 218-346-6664

## TIMELESS PRODUCTS

**New! "TP 125 V"**  
**128 Channel Converter with Volume**

**Special Prices for TP1550PC**  
**Call for Details**

**Panasonic still available!**

- REFURBISHED CONVERTERS ALSO AVAILABLE •
- QUALITY REPAIR DEPARTMENT FOR ALL YOUR TUNER REPAIRS •
- REMOTES AVAILABLE FOR MOST CABLE BOXES •

DEALERS ONLY • GREAT QUANTITY PRICES • NO DECODER SALES



**Professional 10 HOUR RECORDER** Factory Direct  
**"BUILT LIKE A BATTLESHIP"**

- Heavy duty commercial recorder - NOT improvised from consumer models
- 12, 14, and 16 hour models also available
- BUILT-IN voice activation (add \$30)
- Applications information included
- Dimensions: 11.5 x 7.0 x 2.75"

**SPECIAL Nuts & Volts Price..**  
**\$159**

**FREE** 48-PAGE SPECIAL EQUIPMENT CATALOG!

COD's OK. Sorry, no credit cards. Free catalog USA only, other countries \$5. Price includes UPS to 48 States on Pre-Paid Orders

**Viking International** 150 Executive Park Blvd. #4600 San Francisco, CA 94134  
 Phone: (415) 468-2066 • Fax: (415) 468-2067 • Web: [www.vikingint.com](http://www.vikingint.com)

Write in 88 on Reader Service Card.

**YOU WIN!**

**Subscribe today!!**

and be **automatically** entered each month in our Prize Drawing!

**See our ad on page 54 for more details and this month's prize!**

# SUMMER SPECIALS

## SUPER SAVING UPGRADE KIT

### M. BOARDS WITH CPU, 8MB AGP & SOUND:

K6-2 300 Mhz MMX	\$149
K6-2 350 Mhz MMX	\$169
K6-2 380 Mhz MMX	\$189
K6-2 400 Mhz MMX	\$199
K6-2 450 Mhz MMX	\$239
K6-3 400 Mhz MMX	\$349
Pentium II Celeron 333 w 128Kcache	\$169
Pentium II Celeron 400 w 128Kcache	\$219
Pentium II 350 MMX	\$269
Pentium II 400 450 MMX	\$369 Scall
Pentium III 450 500 MMX	\$425 call

### CASES WITH POWER SUPPLIES

MED TOWER CASE PREMIUM.....	\$29
ATX MED TOWER CASE PREMI..	\$49

### FLOPPY

44 Mitsumi	\$ 18.95
------------	----------

### MONITORS

14" 28 108 N-I, Low Radiation.....	\$119
15" 28 1024x768 N-I, Low Rad.....	\$135
17" 28 1280x1024 N-I, Low Rad.....	\$229

### KEYBOARDS

104 Keyboard.....	\$10
Keytronic.....	\$19
Focus 2000.....	Scall

### VGA CARDS

SVGA 1MB ISA.....	\$35
PCI 1MB/2MB/4MB.....	\$14/22/29
PCI OR AGP 4MB.....	\$29
PCI OR AGP VGA 8MB.....	\$39
BANSHI 16MB.....	\$135
VOODO II 12MB.....	\$119
ANY OTHER VGA CARDS.....	SCALL

### CONTROLLER SCSI

DIAMOND FIRE PORT 40.....	\$95
Adaptec 2940/2940UW/2940UZW.....	\$149/169/379

### MODEM/FAX MODEM

33.6K Voice Modem/Fax Modem.....	\$26
56K Voice Modem/Fax Modem.....	\$29
US ROBOTIC 56K Modem.....	\$89
ISDN.....	SCALL



## 44X CDROM..\$45

## Orders & Price

Tel: (800) 899 6430

## 44X Bundle

**\$69**

40X Speed CD  
16 Bit Sound Card  
with Wavetable.  
Amplified Speakers 80W

For ALL kinds of Drives, Sound Cards  
Speakers and CD Titles: \$Call

## HARD DRIVES SPECIALS

4.3GB..\$125	6.4GB..\$139	8.4GB..\$156	10GB..\$175
13.5GB..\$215	17GB..\$289	21GB..\$355	any other CAL

## IBM 6X86 300MMX

Motherboard  
CPU, 8MB AGP  
VGA & SOUND  
**\$129**

## Siml Memory LOW \$\$\$

Will beat any price  
Resellers  
Dealers  
Welcome

## AMD K6-2 350 MMX

Motherboard  
CPU, 8MB AGP  
VGA & SOUND  
**\$179**

## CREDIT CARDS OK

us out  
No Minimum Charge. No Hidden Charge.  
Prices subject to change without notice.  
15% Restocking fee for Non Defective Items.  
Orders of \$950 or more, ground shipping free,  
except for Cases, Monitors, Keyboards and F.Drives.

## EVERYDAY LOW PRICES

**www.bisme.com**

**BISME COMPUTERS OUTLET** 906 N Carpenter Rd. Suite A. Modesto, CA 95351

Write in 89 on Reader Service Card.

**CABLE CONVERTER REPAIR:** Quality repair service for all name brands. If you're tired of the runaround you're getting from the company you purchased it from, or they're out of business. Give us a call for fast and courteous service. Have model and problem ready. Sorry no box, chip, or IL repairs. **Highview Engineering 815-245-3735** or E-Mail: [HIGHENG1@AOL.COM](mailto:HIGHENG1@AOL.COM) ask for George.

**WELD ALUMINUM WITH PROPANE!** EZ, INEXPENSIVE, STRONG. DETAILS: WEEKS, 36 CAROLINA ST., TAYLORS, SC 29687. 1-800-547-WELD(9353) FAX 864-244-6349. <http://www.dura-fix.com>

**PRINTED CIRCUIT** design by professional with 30+ years: conventional, multilayer, downhole, fine line. Prototype and production fabrication. Reverse engineer existing 2-layer board. [www.circuit-applied-tech.com](http://www.circuit-applied-tech.com) call toll free 877-236-3223.

**PLAYSTATION MOD** chips. Works with all models up to 750x. Color instructions. Seven wire hook up, does not come with wires. \$5 each, plus shipping charges. 10% discount for 10 or more. Call 703-741-0338 to place an order.

**Closing Date For Next Issue — June 5th**

# ALFA ELECTRONICS HIGH QUALITY TEST EQUIPMENT

Visit [www.alfaelectronics.com](http://www.alfaelectronics.com) for complete info

Call 1-800-526-2532 for Order and Free Catalog

DMM	LOG/COUNTER	FLUKE	SPECIALTY
<b>DMM-895 (\$179.00):</b> true rms, AC/DC (V,A), $\Omega$ , bar graph, freq, capac., dBm, logic, diode <b>DMM-23T (\$99.95):</b> 4 1/2 digit, true rms, high resol. (10 $\mu$ V, 10nA, 10m $\Omega$ ), hFE, diode, contin. <b>DMM-20 (\$74.95):</b> AC/DC (V,A), Freq, cont., Capac, Induct., $\Omega$ , hFE, diode, duty cycle <b>DMM-122 (\$59.95):</b> DC/AC(V,A), $\Omega$ , hFE, diode, capacitance, freq, logic, continuity <b>DMM-123 (\$44.95):</b> DMM + capacitance, DC/AC(V,A), $\Omega$ , hFE, diode, continuity <b>DMM-10 (\$19.95):</b> 3 1/2 digit, DC/AC V, $\Omega$ , hFE, diode, signal output(+3V, -0.5Vsq, 50% duty)	<b>CAP-15 (\$49.95):</b> 3 1/2 digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution, zero adjustment. <b>LCR-24 (\$119.95):</b> 0.1 $\mu$ H-200H, 0.1pF-2000 $\mu$ F, 0.01 $\Omega$ -20M $\Omega$ , diode test. New Model. <b>LCR-131D (\$219.95):</b> autorange, 0.1 $\mu$ H-10kH, 0.1pF-10mF, 1m $\Omega$ -10M $\Omega$ , Q Factor, serial/parallel, 120Hz/1kHz testing mode. <b>FC-1200 (\$129.95):</b> 1.25GHz counter, Handheld, 8 digits display, 10ppm accuracy, sensitivity 5mV (130-350MHz), 30mV (440MHz)	<b>12B \$94.95</b> <b>70-III \$99.00</b> <b>73-III \$125.00</b> <b>75-III \$155.00</b> <b>77-III \$173.00</b> <b>79-III \$195.00</b> <b>87-III \$325.00</b> <b>92B-III \$1,445</b> <b>96B-II \$1,695</b> <b>99B-III \$2,095</b> <b>105B \$2,495</b> <b>123-III \$1,130</b> <b>863E \$555</b> <b>867B \$740</b>	<b>AC Current Probe \$34.95</b> <b>DC/AC Current Probe \$79.95</b> <b>Mini AC Clamp \$59.95</b> <b>AC Clamp w/temp \$89.95</b> <b>DC/AC Clamp \$109.95</b> <b>Thermometer \$69.95-\$89.95</b> <b>IR Thermometer \$189.95</b> <b>Sound Level Meter \$169.95</b> <b>Tachometer \$169.95-\$219.95</b> <b>EMF Tester \$69.95</b> <b>Pressure Meter \$299.95</b> <b>Watt Meter \$129.95</b> <b>High Voltage Probe \$59.95</b> <b>pH Meter \$79.95</b> <b>Light Meter \$79.95-\$89.95</b>

## GW/INSTEK® DC POWER SUPPLIES

20 MHz Scope	100MHz Cursor	Triple Output	Single Output	Programmable	FUNCTION GENERATOR	BENCHTOP DMM
<b>OS-620 \$304.95</b> • Most economical scope • Dual CH/X-Y operation • 1 mV/div sensitivity • Z-axis input, CH1 output • TV syn, ALT trigger • 2 probes (x1, x10)	<b>OS-6103 \$1199.95</b> • Cursor Readout & meas • Dual CH / Delay sweep • 10 panel setting memory • Time base auto-range • Z-axis modulation input • 2 probes (x1, x10)	• 2 variable out 0-30V, 0-3A • One fixed 5V, 3A output • IEEE-488.2 and SCPI compatible command set • Const. volt, current mode • 4 analog or 2 digital display • PC-3030 (\$499.95) • PC-3030D (\$549.95) digital	• Const voltage, current mo • Voltage regulation $\leq 0.01\%$ • Current regulation $\leq 0.2\%$ <b>PS-1830 (\$198.95)</b> 18V/3A <b>PS-1850 (\$214.95)</b> 18V/5A <b>PS-1830D (\$214.95)</b> 18V/3A <b>PS-1850D (\$244.95)</b> 18V/5A	• Auto serial/parall (PPT ser) • Auto track (PPT series), • Sine/Sqr/Tri/Pulse/Ramp • IEEE-488.2 and SCPI compatible command set <b>PPS-1860G (\$1,149.95)</b> 18V/6A <b>PPS-3635G (\$1,499.95)</b> 36V/5A <b>PPT-1830G (\$1,499.95)</b> 18V/3A <b>PPT-3615G (\$1,499.95)</b> 36V/1.5A	<b>FG-8015G (\$157.95)</b> • 0.02Hz-2MHz <b>FG-8020G (\$209.95)</b> • 0.02Hz-2MHz w/counter <b>FG-8050 (\$449.95)</b> Sweep • 0.006% accuracy, GPIB • INT/EXT AM/FM mod	<b>DM-8034 (\$179.95)</b> 3 1/2 dgt • AC/DC(V,A), $\Omega$ , diode <b>DM-8040 (\$339.95)</b> 3 1/4 dgt • ACV to 50kHz, true rms <b>DM-8055G (\$889.95)</b> 5 1/2 dgt • 0.006% accuracy, GPIB • dBm, auto REL, min/max

**ALFA ELECTRONICS** P.O. BOX 8089 PRINCETON, NJ 08543-8089  
 TEL: (800) 526-2532 / (609) 897-1135 FAX: 609-897-0206  
 E-mail: [sales@alfaelectronics.com](mailto:sales@alfaelectronics.com)

Write in 90 on Reader Service Card.





### ECLIPSE INFRARED REMOTE CONTROL

Forty-seven buttons! build a remote-controlled robot ... or something.

97V012 \$4.95 each



### ULTRASONIC TRANSDUCER

Polaroid transducer is for use measuring distance and object detection. Operating frequency 50-60KHz. Nom bias 150VDC, Nom AC drive 150VAC peak, max combined 400V, Nom capacitance @ 1KHz 400-500pF. Documentation included.

99U001 \$19.95

### PC BOARD DRILLS

Used. Serviceable. Assorted sizes. 99Z002 50 for \$19.95



### VARIACS

Enclosed in vented case with knob and scale. 6ft. line cord, panel mounted socket, meter, and fuse. New.

2000VA \$129.95  
1000VA \$89.95



### REMOVABLE HARD DRIVE

Syquest SO555 44MB removable SCSI cartridge hard drive. (Removed during upgrade)

97C024 \$9.95 each

### IDE CARD

Creative Labs #CT1870. (For individual cards, see 96C012). Dealer inquiries invited.

98C007 Box of 20 \$19.95

### GENUINE 14X JEWELER'S LOUPE

High-quality glass Hastings Triplet flat field loupe made in the USA by Bausch & Lomb. If you're in the field searching part numbers on components or serial numbers on equipment, this little gem could pay for itself the first time you use it.

98Z012 \$15.95 each



### LED FLASHLIGHT

This flashlight is the newest in portable lighting technology. Three "AA" alkaline batteries will give 60 hours of light when you use the PL-W1 with one LED. There's no bulb to replace. This is a great light for cavers, backpackers, boaters and anyone who doesn't want to carry a lot of batteries and wants a dependable light. Put one into your Y2K "survival kit."

PL-W1 (1 LED) \$14.95  
PL-W2 (2 LEDs) 19.95  
PL-W3 (3 LEDs) 24.95

### 12VDC BUEHLER GEARMOTOR

No Load: 60 mA, 62 RPM. Full Load: 155 mA, 47 RPM. Load Torque: 17 oz./in. Gear Ratio: 106:1. Cast case, sintered bronze bearings. Dimensions: 40 x 40 x 29 mm. Shaft: 3 mm dia x 10 mm long. Rotation: clockwise, facing shaft.

98M005 \$11.95 each



### LOCTITE REMOVEABLE THREADLOCKER

Type 242. 0.34-oz. (10ml) bottle. 99Z001

\$2.49 each

### "SPAGHETTI"

18-Ga. teflon, for jumpers and component leads. 25-ft. roll.

99W009 \$4.95/roll



### ATARI 1020 COLOR PRINTER

For all Atari 8-bit computers. (Not PC-compatible!) Package includes: printer, power supply, software, pens, paper and interface cable. These are new units in factory sealed boxes.

94C037 \$14.95 each



### TV AUDIO DEMODULATOR

Originally used in cable TV application, this subassembly takes channel 3, 4 or 5 signal and demodulates the audio. Comes with documentation and schematics, plus additional schematics to build add-on video demodulator board.

92A028 \$9.95 each



### 13.8 VDC BENCH POWER SUPPLY

MG Electronics PS-8. Input voltage: 105-125 VAC 60 Hz. Output voltage: 13.8 VDC, 8A. Brand new!

96E001 \$49.95



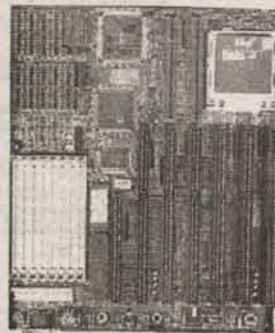
### BATTERY HOLDER

4 AA Cells. 93E018 89¢ each  
93E003 5 for \$4.00



### MINI TOWER POWER SUPPLY

Pulled from unused equipment. 96C009 \$9.95 each



### '486 MOTHERBOARD

Comes with a 25MHz 486-SX CPU. Board supports SX25, SX33, DX25, DX33, DX40, DX50, DX2-50, DX2-66, DX2-80. Does not support DX4 CPUs. All info silkscreened on board. Seven ISA slots and 2 VESA local buss extensions. Used, tested good. While supplies last...

98C014 \$29.95 each



### HPiB/GPiB CABLES

Your choice for \$24.95 each.  
HPiB-1 (1 Meter)  
HPiB-2 (2 Meter)



### ECOHEAT™ HEAT GUN

An economical, lightweight, multi-use heat gun with two heat settings (500° and 1000°F). Has 3-position slide switch, built-in hand guard, 3-wire grounded cord, thermoplastic case. UL listed, 120VAC.

EC-100 \$32.95 each



### ULTRAMINIATURE CAMERA

Black and white 3.6mm camera. It has 430 lines of resolution, minimum illumination is .03 Lux. 8-12VDC (9V standard) at 80 ma. It has a built in microphone. Sensitivity = -60dB, 20Hz-20KHz, audio out 1V/600 ohms. It has a flat front pinhole lens and metal housing. Dimensions are: 25mm X 25mm X 16mm. It includes 9V AC adapter.

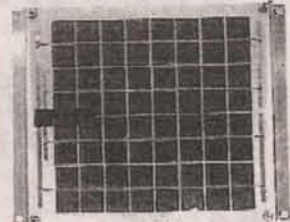
99V001 \$89.95



### INFRA-RED CAMERA

This is a 3.6mm CCD camera with 430 lines of resolution. Minimum light-level is .03 Lux. 6 IR LED's onboard for illumination. Microphone, sensitivity is -60dB, audio out is 1V/600 ohms. Includes AC adapter.

99V002 \$79.95



### SOLAR BABY

Open circuit: 18.5V. Peak power: 15VDC at 333mA (5W). Ideal for recharging lead acid batteries. Sturdy aluminum frame on fiberglass-backed panel measures slightly less than 11" square. Wires included for easy hookup.

98E024 \$58.00 each



### ION PROPULSION MOTOR

This amazing device demonstrates the basic propulsion principles used in NASA's Deep Space ion engine!

The Ion Motor creates a high voltage potential that generates four streams of "ION WIND". The ion streams exert a reactive force that spins the rotor like a top.

This item makes a great science fair project or an interesting desk-top toy. The Ion Motor also generates negative ions which can reduce pollen and pollution in the air to produce a healthier environment.

Complete Ion Propulsion Motor

99K001 ONLY \$29.00



### LOWPASS FILTER

TTE Bessel 10 pole filter. 3Db cornerfrequency 350KHz. In and out impedance 75ohm. Min. stop band attenuation 60dBc. PC mount. Dimensions are 3.33" length X 1" width X .5" diameter.

99P003 \$19.95



### Back In Stock! PIEZO HORN TWEETER

Frequency response 4KHz to 40KHz @ 35V RMS. Measures 3.375" square at the horn flange by 2.75" deep.

95V010 \$4.95 each



### LCD DISPLAY

1 Row, 8 characters, with backlit face 1-3/8" x 9/16". Standard 14-pin interface with pinout sheet.

97L001 \$7.95 each



### .015µF 6.5 KV DC CAP

95P017 99¢ each



### 12VDC 80mA FAN

Measures 2" sq. x 0.625" thick. These are new!

96F003 \$4.95 each



### PENTIUM PRO COOLING FAN

12VDC, 0.08A, with heatsink. Sanyo Denki #109P6612H2036.

98F003 \$15.00 each



### UNIPOLAR STEPPER MOTOR DRIVER IC

UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 timer, parallel port, etc. Build your own robot, anything that requires precision positioning.

93I002 \$4.50 each



### PULSE MOTOR

42mm dia., 22mm thick. Shaft: 3mm dia. x 12mm long, with 13-tooth gear approx 16.6mm dia x 5mm thick. 7.5°/step, 48s/rev., 12VDC, 50Ω, 6-wire. With spec sheet.

92M010 \$3.95 each

### COMBO PACK!

One 93I002 IC and 92M010 motor (both shown above) with schematics.

93I003 \$7.95/set



# ALLTRONICS

2300-D Zanker Road - San Jose, CA 95131-1114

World Wide Web: <http://www.alltronic.com>

(408) 943-9773 - Fax (408) 943-9776

Store Hours: 9-6 M-F & 10-3 Sat. - Pacific  
Visa, M/C, AmEx Accepted. All Sales Final.  
California Residents Add Sales Tax.  
Shipping Additional on All Orders.  
Prices Subject to Change Without Notice.  
Prices Good 60 Days from Date of Publication



Send \$3.00 For Our Latest Catalog!  
\$4.50 Foreign. Refundable on First Order.

010599



# Mr. NiCd

# JUNE 99 SUPER SPECIALS!

# THE BEST BATTERIES IN AMERICA!

**Packs & Charger for YAESU FT-50R / 40R / 10R:**

FNB-40xh (5mm NiMH)	7.2v	650mAh	\$41.95
FNB-47xh (NiMH)	7.2v	1800mAh	\$49.95
FNB-41xh (5mm NiMH)	9.6v	1000mAh	\$49.95

**For YAESU FT-51R / 41R / 11R:**

FNB-38 pack (5W)	9.6v	700mAh	\$39.95
------------------	------	--------	---------

**For YAESU FT-530 / 416 / 816 / 76 / 26:**

FNB-26 pack (NiMH)	7.2v	1500mAh	\$32.95
FNB-27s (5mm NiMH)	12.0v	1000mAh	\$45.95

**For YAESU FT-411 / 470 / 73 / 33 / 23:**

FNB-11 pack (5W)	12.0v	600mAh	\$24.95
FBA-10 6-Cell AA case			\$14.95

**Packs for ALINCO DJ-580 / 582 / 180 radios:**

EBP-20ns pack	7.2v	1500mAh	\$29.95
EBP-22nh pk (5W)	12.0v	1000mAh	\$36.95
EDH-11 6-Cell AA case			\$14.95

**For ICOM IC-21A / T22-42A / W31-32A / T7A:**

BP-180xh pk (NiMH)	7.2v	1000mAh	\$39.95
BP-173 pack (5W)	9.6v	700mAh	\$49.95

**For ICOM IC-W21A / 2GXAT / V21AT (Black or Grey):**

BP-132s (5mm NiMH)	12.0v	1500mAh	\$49.95
--------------------	-------	---------	---------

**For ICOM IC-2SAT / W2A / 3SAT / 4SAT etc:**

BP-83 pack	7.2v	600mAh	\$23.95
------------	------	--------	---------

**For ICOM 02AT etc & Radio Shack HTX-202 / 404:**

BP-8h pack	8.4v	1400mAh	\$32.95
BP-202s pack (HTX-202)	7.2v	1400mAh	\$29.95

**For KENWOOD TH-79A / 42A / 22A:**

PB-32xh pack (NiMH)	6.0v	1000mAh	\$29.95
PB-34xh pack (5mm NiMH)	9.6v	1000mAh	\$39.95

**For KENWOOD TH-78 / 48 / 28 / 27:**

PB-13 (original size)	7.2v	700mAh	\$26.95
-----------------------	------	--------	---------

**For KENWOOD TH-77, 75, 55, 46, 45, 26, 25:**

PB-6x (NiMH w/whg plug)	7.2v	1200mAh	\$34.95
-------------------------	------	---------	---------

Mail, phone, & Fax orders welcome! Pay with MasterCard / VISA / DISCOVER / American Express  
**Call 608-831-3443 / Fax 608-831-1082**  
**Mr. NiCd - E. H. Yost & Company**  
 2211-D Parview Road, Middleton, WI 53562  
**CALL OR WRITE FOR OUR FREE CATALOG!**  
 Cellular / Laptop / Videocam / Commercial & Aviation packs too!  
 E-mail: ehyst@midplains.net

# Events CALENDAR

Continued from page 19

**MI - TAWAS** - Hamfest. Iosco County AR Enthusiasts, John Hanley KA8AJP, 517-756-2845. E-Mail: ka8aip@centuryinter.net  
**MO - SPRINGFIELD** - Hamfest. Southwest Missouri ARC, Karen Thorpe N0TDW, 417-889-6775. E-Mail: n0tdw@juno.com  
**NY - PLATTSBURGH** - Hamfest. Champlain Valley ARC, Bernard Jakobetz KC2ALG, 518-643-9657  
**NY - WEEDSPORT** - Hamfest. Auburn ARA, Joe Kahler WA2NGX, 315-364-5135. E-Mail: htx@usa.net  
**OH - COLUMBUS** - Hamfest. Voice of Aladdin ARC, Jim Morton KB8KJP, 614-846-7790  
**PA - MATAMORAS** - Hamfest. Tri-State ARA, Dave W2DRH, 914-856-2529; Ray WY2D, 914-856-1733; Rich K3BBC, 570-559-7401

## AUGUST 7-8

**WA - SPOKANE** - ARRL Eastern WA Section Convention, University High School, 10212 E. 9th Ave. Sat: 9am-5pm, Sun: 8am-12pm. VE Exams. Neil Gallup N7LVO, 509-928-7442. E-Mail: n7lvo@cet.com Betsy Ashleman N7WRQ, 509-448-5821. E-Mail: n7wrq@aol.com  
 Web: http://www.iea.com/~n7utg

## AUGUST 8

**IA - AMANA** - Hamfest. Cedar Valley ARC, Wayne Kolosik K1OFF, 319-393-4224. E-Mail: k1off@usa.net  
**IL - PEOTONE** - Hamfesters Hamfest. Will County Fairgrounds. Tom Davis KB9NUQ, 708-210-9548; David Brasel NF9N, 708-448-0580. E-Mail: nf9n@aol.com or tdavis@internetplus.net  
**OH - LISBON** - Hamfest. Triangle ARC, Mike Mays KB8JNM, 330-386-6021. E-Mail: mike.mays@usa.net Web: http://www.qsl.net/tarc  
**OH - MARTINS FERRY** - Hamfest. Triple States RAC, Ralph McDonough KB8AN, 740-546-3930. E-Mail: kb8an@aol.com  
 Web: http://www.qsl.net/tsrac

## AUGUST 14

**CA - FONTANA** - Inland Empire ARC Amateur

Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**NY - WESTMORELAND** - Hamfest. Rome RC, Jack Roux KB2TXR, 315-336-1391  
**OH - NELSONVILLE** - Hamfest. Sunday Creek AR Federation, Russell Ellis N8MWK, 740-767-2226. E-Mail: scarf@hocking.edu  
**WV - HUNTINGTON** - Hamfest. Tri-State ARA, Dwight Smith WB8JPJ, 304-522-7865 eves; 304-523-6675 days. E-Mail: wb8jpj@arrl.net  
 E-Mail: tara.amateur.radio@juno.com

## AUGUST 15

**CO - GOLDEN** - ARRL Colorado State Convention. Denver Radio Club, Bob Lindell N0YIX, 303-422-0610. E-Mail: Bob.Lindell@compuserve.com  
**KY - LEXINGTON** - Hamfest. National Guard Armory. 8am-4pm. VE Exams. Talk-in: 146.760. John Barnes KS4GL, 606-253-1178. E-Mail: KS4GL@juno.com  
 Web: http://www.qsl.net/k4kjq/  
**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1xm/www/swapfest.html  
**MI - JACKSON** - Hamfest. Cascades ARS, Dennis Byrne KC8IJJ, 517-522-4058. E-Mail: byrned@voyager.net  
 Web: http://www.qsl.net/cars-jxn/  
**NJ - BAYVILLE** - Hamfest. Jersey Shore ARS, Bob Murdock WX2NJ, 732-269-6379. E-Mail: JARSFEST@aol.com. Web: http://members.aol.com/jarsfest/jarsfest.html  
**NY - DEPEW** - Hamfest. Lancaster ARC, Luke Calliano N2GDU, 716-634-4667. E-Mail: lcalliano@freeweb.com. Web: http://hamgatel.sunyerie.edu/~larc/GreaterBuffaloHamfest.ht  
**PA - YORK** - Swapfest and Auction. York VO Tech School, Pauline Dr. (1 blk S of I-83 Exit 6, Rt 74S). 7am. Talk-in: 146.865. Swap Fest, John Salony (Ph) 717-741-1780; Greg Towson (fax) 717-741-0874. Gene Warner (E-Mail) ad3e@arrl.net

# Unicorn Electronics

1142 State Route 18  
 Aliquippa, Pa. 15001

www.unicornelectronics.com

## Components & More!

Celebrating our 17th Year Of Service !!

### DIODE/TRANSISTOR TESTER KIT

This dynamic tester allows checking of transistors & diodes in circuit. Identifies NPN or PNP transistors. Checks all types, small or large power. Identifies anode or cathode of diodes.

STOCK#	1-9	10-24	25+
SB1102	1.99	1.89	1.70
DT100K	24.99	23.74	21.37

### SINGLE TURN TRIMPOT

- 1/2 Watt
- 10% Tolerance
- 3/8" Square
- TO-5 Grid
- Top Adjustment
- Bourns 3386P or equal

STOCK#	DESCRIPTION	1-24	25-99	100+
PO150	50 ?	.59	.56	.50
PO1100	100 ?	.59	.56	.50
PO1500	500 ?	.59	.56	.50
PO11K	1K ?	.59	.56	.50
PO12K	2K ?	.59	.56	.50
PO15K	5K ?	.59	.56	.50
PO110K	10K ?	.59	.56	.50
PO120K	20K ?	.59	.56	.50
PO150K	50K ?	.59	.56	.50
PO1100K	100K ?	.59	.56	.50
PO1200K	200K ?	.59	.56	.50
PO1500K	500K ?	.59	.56	.50
PO11M	1 Meg ?	.59	.56	.50

### ANTI-STATIC FOAM CLEANER

A thick, foaming cleaner for use in static sensitive applications. Safe for plastics and fiberglass. Use on computer cases and all office equipment. Also cleans soft fabrics. 5 oz. aerosol can.

STOCK#	1-9	10-24	25+
SB1102	1.99	1.89	1.70

### What Do We Have ?

- I.C.'s
- Oscillators
- Crystals
- Diodes
- Tools
- Laser Diodes
- Vises
- Resistors
- Capacitors
- Connectors
- Trimpots
- Kits
- Vises
- LED's
- Transistors
- And more!

### TELEPHONE KIT

Build this high-tech, see-thru plastic telephone. Learn theory on how telephones work. Flashing neon lamps when phone rings. Redial system and wall mount included. Comes complete with manual.

STOCK#	1-9	10-24	25+
K30	15.99	15.19	13.67

### FM MICROPHONE KIT

Transmit your voice on any FM radio. Range up to 1000'. Case included

STOCK#	1-9	10-24	25+
K30	15.99	15.19	13.67

### ANTI-STATIC CLEANER

General purpose cleaner for use in static sensitive applications. Safe for plastic and fiberglass. 1.75 oz. non-aerosol bottle.

STOCK#	1-9	10-24	25+
SB1101*	.99	.94	.85

### HEAT SINK

- Thermalloy # 6073
- TO-220 type
- .75" square x .375" high

STOCK#	1-24	25-99	100+
HS1001	.19	.18	.16

### PEAKING COIL

- TDK # H301CL-R391
- 390 µh
- .375" diameter

STOCK#	1-24	25-99	100+
SB1037	.15	.14	.13

ORDER TOLL FREE! - 1-800-824-2432 • FAX ORDERS - 724-495-7882  
**NO SHIPPING CHARGES !!!**

### 41 WATT SWITCHING

- Input - 115/230V
- Outputs - +5V @ 3.75 Amps
- +12V @ 1.5 Amp
- -12V @ .4 Amp
- Size - 5.25" W x 7" L x 2.50" H

STOCK#	1-9	10-24	25+
PS1003	9.99	9.49	8.54

### 11 PIECE COMPUTER TOOL KIT

11 piece kit containing:  
 • 3/16" & 1/4" nut driver  
 • 3 prong parts retriever  
 • Tweezer  
 • 3/16", 1/4", #1 & #2 phillips reversible screwdriver  
 • T-10 & T-15 reversible screw driver  
 • 14-16 pin IC inserter  
 • 1/8" flat screwdriver  
 • Black vinyl zippered case

STOCK#	1-9	10-24	25+
TK1100	19.99	18.99	17.09

### PROTOBOARD DESIGN STATION



- The total design workstation including expanded instrumentation, breadboard and power supply
- Ideal for analog, digital and micro processor circuits
- 8 logic probe circuits
- Function generator with continuously variable sine, square, triangle wave forms, plus TTL pulses
- Triple power supply offers fixed 5 VDC supply plus 2 variable outputs - +5 - 15 VDC and -5 - 15 VDC
- 8 TTL comp. LED indicators, switches
- Pulsers
- Potentiometers
- Audio experimentation speaker
- Multiple features in one complete test instrument saves hundreds of dollars needed for individual units
- Unlimited lifetime guarantee on breadboard sockets

STOCK#	1-9	10-24	25+
PB503	299.99	284.99	256.49

### SLIDE DIP SWITCHES

- SPST
- 50 VDC @ 100 ma
- Numbered switches
- .100" spacing

STOCK#	DESCRIPTION	1-24	25-99	100+
SW4S	4 Position	.59	.56	.50
SW5S	5 Position	.59	.56	.50
SW6S	6 Position	.59	.56	.50
SW7S	7 Position	.59	.56	.50
SW8S	8 Position	.59	.56	.50
SW10S	10 Position	.69	.66	.59
SW12S	12 Position	.69	.66	.59

### RCA JACK

- PC Mount
- Vertical or rt. angle
- Metal body

STOCK#	1-24	25-99	100+
CORCA	.19	.18	.16
CORCARA	.19	.18	.16

### PADLE SWITCH

- SPDT/off-on
- 3 amps @ 125 VAC
- Solder tail
- 9/16" x 7/8" mounting

STOCK#	1-24	25-99	100+
SW1004	.39	.37	.33

### PROTOLAB

A state of the art electronics lab for your PC. You can build & experiment with actual circuits, choosing from an unlimited number of components. Then, analyze your circuits with built-in high-tech instruments. This complete electronics lab simulates thousands of dollars worth of parts and instruments. Plus you get a unique experiment book. Easy to use, menu driven, mouse controlled circuits come alive on your screen. You can't blow up your 'lab' because it's fool-proof & safe on your PC!

STOCK#	1-9	10-24	25+
PROTOLAB	49.99	47.49	42.74

### PRINTER CLEANING KIT

Contains:  
 • 100 ml safety solvent spray  
 • 10 G.P. wipes  
 • Static reducing cloth  
 • Disposable gloves  
 • Brush

STOCK#	1-9	10-24	25+
SB1108*	1.99	1.89	1.70

### INFRA-RED COLLIMATOR PEN

A low power collimator pen containing a GaAlAs laser diode. Pen delivers 2.5mW @ 820nm. Operating voltage of 2.2-2.5V @ 90-150mA is designed for lower power applications. The stainless steel case measures 11 mm in diameter and 27 mm long.

STOCK#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

### EPROMS

STOCK#	1-24	25-99	100+
2732A-20	5.49	5.22	4.70
2764-20	5.39	5.12	4.61
2764-25	4.49	4.27	3.84
2764A-20	3.49	3.32	2.99
2764A-25	2.99	2.84	2.56
27C64-15	2.99	2.84	2.56
27256-15	4.79	4.55	4.10
27C256-15	2.99	2.84	2.56
27512-25	3.09	2.94	2.65
27C512-25	2.99	2.84	2.56
27C010-15	2.79	2.65	2.39
27C020-15	3.49	3.32	2.99
27C040-12	5.49	5.22	4.70
27C080-12	10.99	10.44	9.40

### CHOKE

- Postage stamp type
- .375 W x .500 H
- 10 µh @ 0.5 A

STOCK#	1-24	25-99	100+
SB1070*	.12	.11	.10

# WIDGETS

Sensors to RS232, 422 or 485

Starting at \$199

PRESSURE  
 THERMOCOUPLE  
 RTD  
 VOLTAGE  
 CURRENT  
 MOTION  
 GASES  
 RH  
 And more

Each system comes complete with one sensor, 10, 12 or 14 bit resolution w/ 7 extra channels of A/D, 30k of remote data storage, power supply, serial cable and WINLP-Lite data acquisition software (trending, storing and display)

1-888-597-3588 (530) 647-2028

LEMON-PLADD INC. FAX (530) 647 8951  
 PO Box 1683 POLLOCK PINES CA. 95726  
 WWW.LEMONPLADD.COM

Write in 108 on Reader Service Card.

Write in 109 on Reader Service Card.

Nuts & Volts Magazine/JUNE 1999 65



# Questions & Answers

# TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

## QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to [forum@nutsvolts.com](mailto:forum@nutsvolts.com)

**Editor's Note - Please check our web site at [www.nutsvolts.com](http://www.nutsvolts.com) for more questions that were not printed due to lack of space.**

I have three motion security lights on the outside of the house. When I try to use my ham transmitter in the late evening, it puts all the lights on.

Any ideas to keep them from coming on?

**6991 via Internet**

I have a "big dish" satellite system which uses a feed horn polarization motor that rotates the antenna for proper polarization. The motor has three leads. Black for ground, red for +5 volts, and white for pulses which cause the motor to rotate.

I do not understand how the pulses can rotate the motor in both directions, and also how the receiver determines just what the angle is. When the receiver sets the polarization for maximum signal, it causes the motor to rotate in one direction, and then in the reverse direction, and then back to where the signal is maximum.

The angle of rotation is shown on the TV display in the range from -90° to +90°.

I would like to be able to bench test the motor. It would help to know how the receiver determines the angle of rotation, since there doesn't seem to be any feedback from the motor shaft location to the receiver.

**6992 Robert Fankhauser Yelm, WA**

Recently, I subscribed to your magazine and admit to being a beginner with a strong interest in electronics. I committed to creating a buzzer and contestant identification light set-up for my high school debate club to use during competitions. I need help with the circuit design for this purpose. The requirements are:

1. A single buzzer to sound for two seconds when the first contestant to press their button wants to answer the question. The first press should prevent any other contestant from tripping the buzzer.

2. A light should turn on in front of the contestant that was able to turn on the buzzer and stay lit for the time that contestant is answering the question.

3. There needs to be a total of eight press/release buttons with lights arranged for two teams of four.

4. Some way to reset the system for the next round of questioning is important.

5. If you can specify RadioShack parts that would be great.

**6993 Lloyd Harris via Internet**

When replacing the 6JS6C final tubes in the Model 101FT, Yaseu says they should be replaced with matched pairs. Does anyone know how to use unmatched pairs? Years ago, Yaseu came out with a modification to do this, but I am unable to obtain the information.

**6994 Philip Petrus White Plains, NY**

I need a computer program that enables me to make a polar map (a great circle map) with any QTH being the center.

**6995 J. P. Dawson Edmond, OK**

I need an inexpensive device to register the frequency of a PTO driven generator, so I can adjust the engine speed for 60N. It should read from 50 CPM to 65 CPM.

**6996 John W. Coble, Jr. Jacksonville, AR**

## ANSWERS

**ANSWER TO #49917 - APR. 1999**  
I hope to construct a series of

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

## QUESTION INFO

### TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 4) Other Similar Topics

### INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

### HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

*61 selective band-pass filters to be used with outputs of music synthesizers.*

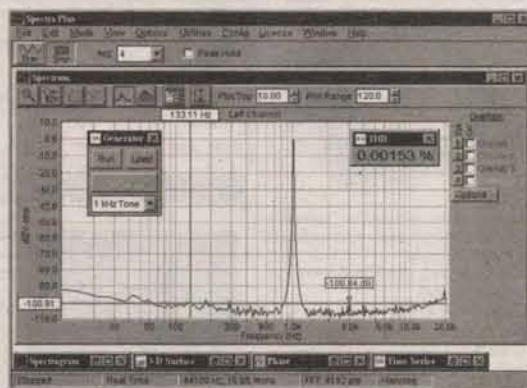
The only practical way to do this is with a DSP (Digital Signal Processor). It won't take much horsepower, so even the least expensive of the evaluation boards from Analog Devices or TI would do.

You will have to program the DSP, however, even if you need to learn how to do this it will take less time than designing, fabricating, and tuning 61 filters. Also, unlike the bank of analog filters, the DSP won't drift

## Turn Your Multimedia PC into a Powerful Real-Time Audio Spectrum Analyzer

### Features

- 20 kHz real-time bandwidth
- Fast 32 bit executable
- Dual channel analysis
- High Resolution FFT
- Octave Analysis
- THD, THD+N, SNR measurements
- Signal Generation
- Triggering, Decimation
- Transfer Functions, Coherence
- Time Series, Spectrum Phase, and 3-D Surface plots
- Real-Time Recording and Post-Processing modes



### Applications

- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

### System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
- Mouse and Math coprocessor
- 16 bit sound card

**Priced from \$299**

(U.S. sales only - not for export/resale)

**DOWNLOAD FREE 30 DAY TRIAL!**

[www.spectraplus.com](http://www.spectraplus.com)

**PHS** Pioneer Hill Software  
24460 Mason Rd.  
Poulsbo, WA 98370  
a subsidiary of Sound Technology, Inc.



**Spectra Plus**  
FFT Spectral Analysis System

Sales: (360) 697-3472

Fax: (360) 697-7717

e-mail: [pioneer@telebyte.com](mailto:pioneer@telebyte.com)



over time and you can change the bandwidth and center frequency or even the number of filters by simply changing the software.

Finally, the DSP should be cheaper than all of the parts needed for that filter bank. It will certainly take less space.

The essence of tone detection is the FFT (Fast Fourier Transform). Your input is a voltage whose amplitude varies over time. The DSP will digitize that signal, then compute its FFT. The result of that computation is a histogram or plot of amplitude vs. frequency.

Since the computation is done on a digitized signal, the computation results in amplitudes at discrete frequencies or bins. By proper selection of program parameters, these bins can be made to correspond to the center frequencies and bandwidths of the filters you desire. Now all you need to do is check each bin for an output greater than a certain threshold to know if that particular frequency component was present.

Digital signal processing can get extremely complicated, however, Analog Devices and probably some others publish basic textbooks with program code that make DSP easy even for a relative beginner.

An evaluation board can be had for less than \$100.00, and a complete set-up with documentation and software for less than \$200.

This is comparable to many microprocessor development systems and is less than the cost of the parts for 61 analog filters. If you're motivated and are at all familiar with rudiments of computer programming, then DSP should not be an impossible hurdle.

**Dave Sarraf**  
via Internet

#### ANSWER TO #4995 - APR. 1999

*Needs visual phone ring indicator for office cubicle.*

Here is what I would try for a remote telephone ring indicator: Purchase a microphone (RadioShack #33-3019), amplifier (277-1008), an output phone plug (274-287), an LED (276-086), and a current limiting resistor (271-1315).

Connect the resistor in series with the LED to the phone plug, with enough wire to reach the top of the cubicle. Plug the phone plug into the earphone jack of the amplifier and adjust the volume to light the LED when the phone rings.

You will want an AC adapter (273-1455) rather than using batteries. If the LED is not bright enough, parallel two resistors. To get 360° visibility, point the LED straight up and put a spherical reflector above it.

**Russell Kincaid**  
Milford, NH

#### ANSWER TO #4994 - APR. 1999

*I would like to read Caller ID information from my modem with Visual Basic 4.0 or 5.0.*

I have used my Caller ID compat-

When Visiting Disney World And Sea World...  
Come To The World Of Electronic Surplus!

## SKYCRAFT

PARTS & SURPLUS, INC.  
ORLANDO, FLORIDA



Located At The Intersection Of I-4  
And Fairbanks Avenue.

Self-Service Retail Outlet Featuring Commercial  
And Government Electronic Surplus Including:

- |                    |                       |
|--------------------|-----------------------|
| ★ WIRE             | ★ COAX                |
| ★ SWITCHES         | ★ RELAYS              |
| ★ RESISTORS        | ★ HARDWARE            |
| ★ TRANSISTORS      | ★ CAPACITORS          |
| ★ TRANSFORMERS     | ★ PANEL METERS        |
| ★ TEST EQUIPMENT   | ★ CIRCUIT BOARDS      |
| ★ NI-CAD BATTERIES | ★ INTEGRATED CIRCUITS |

★ ★ ★ ★ ★ ★ ★ ★

**We Buy Surplus  
Electronic Parts —  
FAX your list.**

[www.skycraftsurplus.com](http://www.skycraftsurplus.com)

FAX 407/647-4831

PH 407/628-5634

P.O. BOX 536186

ORLANDO, FLA. 32853-6186

**HOURS:**  
Monday - Friday 8:30-6:00  
Saturday 8:30-5:00



# ACP's 92nd GIANT COMPUTER SWAP★MEET

Orange  
County's  
Original!



All Day  
Sunday 8am-2pm

# July 25th

**FREE** Admission & Parking  
Shop 100's of Sellers

**In ACP's Giant Parking Lot !!!**

Advanced Computer Products, Inc.

# ACP SUPER★STORE

Since 1976

1310 E. Edinger  
Santa Ana, CA  
714-558-8813



ible modem for that purpose. I have a U.S. Robotics 56K winmodem. You use the Caller ID command "AT#CID=" <argument>. The arguments are either 0, 1, or 2. Zero disables CID, "1" returns formatted CID info, and "2" returns the unformatted CID info.

You send this command to the modem and then monitor the serial port where the modem is installed.

After the first ring, the modem will return the Caller ID info as if it were coming from the serial port, all Basic has to do is read the com port input.

You can get an explanation of this command at <http://ae.pcd.usr.com/techref/commands/voice>

/CID.htm

**Van Dubansky**  
Terryville, CT

#### ANSWER TO #49911 - APR. 1999

*The military has been using a "cigarette pack size" electronic device to remove sulfation from car batteries. I am looking for the circuit.*

This sounds a good deal like a battery charge controller/pulser.

For items such as these (with applications both in the car collecting field and the home power field — photovoltaic cells charging batteries to run your house), I recommend reading: **Home Power** (ISSN:1050-2416), P.O. Box 520, Ashland, OR 97520. <http://www.homepower.com>

.com

Also full of ads, and great articles. They too may have run an article in the past with a schematic. I can't find my master reference at the moment. However, one ad that comes immediately to mind is: **Abraham Solar Equipment**, 124 Creekside Pl., Pagosa Springs, CO 81147; 1-800-222-7242, 970-731-4675.

They advertise a "PowerPulse" battery maintenance system, the pictures in the ad show before and after the use of their device, with the sulfates that covered the plates in photo one, and gone in photo two. Sounds like just the device he is looking for.

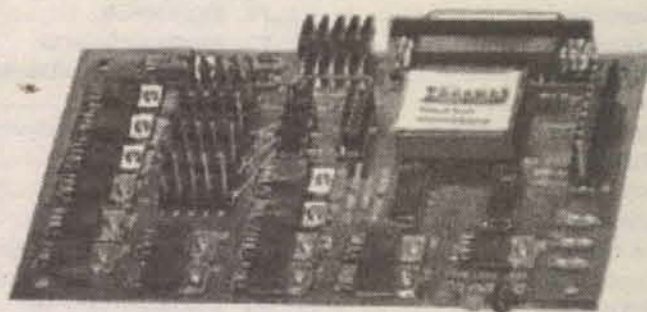
Continued on page 82

## ADDRESSABLE STEPPER MOTOR CONTROLLER

The PARAMAX stepper motor controller is a PC parallel port based addressable controller capable of simultaneous operation of 4 uni-polar stepper motors ranging in voltages from 5 to 12 volts at up to 2 amps per phase. The PARAMAX stepper motor controller includes 8 digital inputs with a data throughput rate of 500k bytes per second. Using the unique PARAMAX addressing method, up to 256 controllers can simultaneously function from a single parallel port. The programming package includes libraries that allow you to create applications both under Windows and DOS. Included libraries are: C++, Pascal, Delphi, Basic and utilities for DOS and Windows.

Also available at:  
**FORD ELECTRONICS, INC**  
(714) 521 - 8080

Part Number: JWP1X-1A  
**\$199.95**



**PARAMAX INC.**  
(800) 473 - 8080

Come and visit us on the internet at:  
[www.paramax.net](http://www.paramax.net)



# HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or **CAPPED** words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and Nuts & Volts account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

**NUTS & VOLTS MAGAZINE**, 430 Princeland Ct., Corona, CA 91719.

## RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **\$1.20** per word. There is a **\$9.00 minimum** charge per ad per insertion.

## WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or **CAPS** are each **10¢** extra PER WORD. **BOLD CAPS** are **20¢** extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are **NOT** charged as all cap words. Use a two-letter abbreviation for states.

## PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **\$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **\$5.00** to enlarge, reduce, or duplicate line

art, or **\$8.00** for halftone of photographs. To **BOX** your ad, include an additional **\$50.00** for copy-only ads, or **\$75.00** for ads with art or photos.

## FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your **Nuts & Volts** account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

## DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

## IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the **60¢** rate only through their subscription expiration date. **NO REFUNDS.** Credit only. No credit for typesetting errors will be issued unless you **clearly** print or type your ad copy.

*Choose a category for your ad from the classifications listed below.*

10. Ham Gear For Sale	80. Test Equipment	120. Components	155. Manuals/Schematics Wanted
20. Ham Gear Wanted	85. Security	125. Microcontrollers	160. Misc. Electronics For Sale
30. CB/Scanners	90. Satellite Equipment	130. Antique Electronics	170. Misc. Electronics Wanted
40. Music & Accessories	95. Military Surplus Electronics	135. Aviation Electronics	175. BBS & Online Services
50. Computer Hardware	100. Audio/Video/Lasers	140. Publications	180. Education
60. Computer Software	110. Cable TV	145. Robotics	190. Business Opportunities
70. Computer Equipment Wanted	115. Telephone/Fax	150. Plans/Kits/Schematics	200. Repairs/Service

## ADVERTISER'S INDEX

1A Sales .....	12	Decade Engineering .....	73	Lemos International Co., Inc. ....	41	R.E. Smith .....	74
Abacom Technologies .....	50	DeMar Electronics .....	75	Linear Systems .....	13	Resources Un-Ltd. ....	33
ABC Electronics .....	39	Digital Products Company .....	73	Lynxmotion, Inc. ....	76	Roger's Systems Specialist .....	55
ACP Super Store .....	67	DMD Systems Recovery, Inc. ....	75	M2L Electronics .....	46	Saelig Company .....	58
ActiveWire, Inc. ....	73	Earth Computer Technologies .....	46	Matco, Inc. ....	73, 75	SAM Electronics .....	13
Advanced Educational Systems .....	88	Edlie Electronics, Inc. ....	18	MCM Electronics .....	31	Sam's Electronics .....	58
Alfa Electronics .....	63	EDS .....	79	Meredith Instruments .....	41	Scott Edwards Electronics, Inc. ....	81
All Electronics Corporation .....	60	E.H. Yost & Co. ....	65	Metric Equipment Sales, Inc. ....	84	Seabird Technical .....	75
Allison Technology Corporation .....	74, 82	Electro Mavin .....	36	microEngineering Labs .....	89	Sescom, Inc. ....	73
Alltech Electronics .....	16	Electro Tool, Inc. ....	87	Micromint .....	27	Shreve Systems .....	24
Alltronics .....	64	Electronic Goldmine .....	56	Midland Technologies .....	73	SiGEM .....	73
American Innovations, Inc. ....	39	Electronic Products .....	73	Miller Engineering .....	92	Skycraft Parts & Surplus, Inc. ....	67
American Technologies Network Corp. ....	94	Electronic Rainbow Ind., Inc. ....	45	Motron Electronics .....	12	Sky Electronics, Inc. ....	29
AM Research, Inc. ....	25	Electronix Corp. ....	82	Mr. NiCd .....	65	Square 1 Electronics .....	27
Andromeda Research .....	76	Electronix Express .....	93	MSC Electronics .....	75	SuperCircuits .....	36
Antique Radio Classified .....	75	EMAC, Inc. ....	29	MVS .....	35	Surplus Traders .....	74
A.S. Electronics .....	84	EPS .....	75	Netcom .....	11	Techniks, Inc. ....	74
AST Global Electronics .....	81	Equipment Management Technology .....	62	Norcomm .....	71	Techno Lab Digital Systems .....	38
Aventrade .....	74	ExpressPCB .....	26	Northwest Cable & Connector Co. ....	86	Technological Arts .....	92
Aviation Components Corp. ....	73	Fair Radio Sales Co. ....	43	Ocean State Electronics .....	57	Telulex, Inc. ....	56
Baylin Publications .....	53	Foss Warehouse Distributors .....	74	Optoelectronics .....	4	The RF Connection .....	38
Bilocon Corp. ....	75	Gateway .....	42	O.S. Systems .....	52	Timeless Products .....	62
Bisme Computers Outlet .....	63	General Device Instruments .....	74	Parallax, Inc. ....	Back Cover	TNR Technical, Inc. ....	73
Black Feather Electronics .....	52	Glentech, Inc. ....	74	PARAMAX, INC. ....	67	Unicorn Electronics .....	65
Brigar Electronics .....	83	Graymark .....	46	Patco Service, Inc. ....	91	USI Corp. ....	25
Bytech Services .....	41	Halted Specialties Co. ....	3	PCW, Inc. ....	28	V&V Mach. & Equipment, Inc. ....	73-75
C & S Sales, Inc. ....	85	Howard Electronic Instruments, Inc. ....	19	Phelps Instruments .....	82	Velleman .....	40
C and H Sales Company .....	58	H.T. Orr Computer Supplies .....	62	Pioneer Hill Software .....	66	Vesta Technology, Inc. ....	73
Circuit Specialists, Inc. ....	98	Information Unlimited .....	38	Plans-Kits Unlimited .....	73	Viking International .....	63
Communications Surplus .....	73, 75	Inkjet Southwest .....	44	Polaris Industries .....	43	Visitect, Inc. ....	93
Convergent, Inc. ....	61	Intronics, Inc. ....	94	Prairie Digital, Inc. ....	75	Weeder Technologies .....	61
Corporate Systems Center .....	2, 99	Jade Products, Inc. ....	74	Pulsar, Inc. ....	53	Western Test Systems .....	20-21
Cruising Equipment .....	77	JK microsystems .....	75	Quality Kits .....	73	Wholesale Cable .....	70
Cunard Associates .....	28	J-Works, Inc. ....	91	R & D Books .....	35	Worldwyde .....	74
Cyber-Test Incorporated .....	39	La Paz Electronics Int'l. ....	26	R & S Surplus .....	61		
Davilyn Corp. ....	15	Lemon-Pladd, Inc. ....	65	Ramsey Electronics, Inc. ....	59		



## AMATEUR RADIO & TV

Alltronics	64
Communications Surplus	73, 75
Convergent, Inc.	61
Gateway	42
Jade Products, Inc.	74
Lemos International Co., Inc.	41
Matco, Inc.	73, 75
Norcomm	71
Ocean State Electronics	57
Ramsey Electronics, Inc.	59
The RF Connection	38

## ASSEMBLY SERVICES

Bilcon Corp.	75
--------------	----

## BATTERIES/CHARGERS

1A Sales	12
Aventrade	74
Cruising Equipment	77
Cunard Associates	28
E.H. Yost & Co.	65
Jade Products, Inc.	74
Mr. NiCd	65
TNR Technical, Inc.	73

## BUSINESS OPPORTUNITIES

## BUYING ELECTRONIC SURPLUS

ABC Electronics	39
Alltech Electronics	16
Aviation Components Corp.	73
Black Feather Electronics	52
C and H Sales Company	58
Earth Computer Technologies	46
EPS	75
Equipment Management Technology	62
Metric Equipment Sales, Inc.	84
Roger's Systems Specialist	55
Skycraft Parts & Surplus, Inc.	67

## CABLE TV

Foss Warehouse Distributors	74
PCW, Inc.	28
Sam's Electronics	58
Timeless Products	62
Wholesale Cable	70
Worldwyde	74

## CB/SCANNERS

Norcomm	71
USI Corp.	25

## CCD CAMERAS/VIDEO

American Technologies Network Corp.	94
Black Feather Electronics	52
Circuit Specialists, Inc.	98
Decade Engineering	73
Matco, Inc.	73, 75
MSC Electronics	75
Polaris Industries	43
Ramsey Electronics, Inc.	59
Resources Un-Ltd.	33
Seabird Technical	75
SuperCircuits	36
USI Corp.	25

## COMPONENTS

1A Sales	12
Aviation Components Corp.	73
Communications Surplus	73, 75
Convergent, Inc.	61
Electronic Goldmine	56
Electronic Products	73
Electronix Express	93
EPS	75
La Paz Electronics Int'l.	26
Linear Systems	13
Ocean State Electronics	57
O.S. Systems	52
Pulsar, Inc.	53
SiGEM	73
Skycraft Parts & Surplus, Inc.	67
Unicorn Electronics	65
Visitec, Inc.	93

## COMPUTER

Hardware	
ACP Super Store	67
ActiveWire, Inc.	73
Allison Technology Corp.	74, 82
Alltech Electronics	16
AM Research, Inc.	25
Bismar Computers Outlet	63

Bytech Services	41
Corporate Systems Center	2, 99
DMD Systems Recovery, Inc.	75
Earth Computer Technologies	46
Electro Mavin	36
General Device Instruments	74
Halted Specialties Co.	3
La Paz Electronics Int'l.	26
MCM Electronics	31
Northwest Cable & Connector Co.	86
Roger's Systems Specialist	55
Shreve Systems	24
Techniks, Inc.	74

## Software

AM Research, Inc.	25
Bismar Computers Outlet	63
Bytech Services	41
Electronix Corp.	82
Pioneer Hill Software	66
R & D Books	35

## Microcontrollers / I/O Boards

Advanced Educational Systems	88
AM Research, Inc.	25
Bismar Computer Outlet	63
Bytech Services	41
Convergent, Inc.	61
EMAC, Inc.	29
JK microsystems	75
La Paz Electronics Int'l.	26
Lemon-Pladd, Inc.	65
Micromint	27
Motron Electronics	12
MVS	35
O.S. Systems	52
Parallax, Inc.	Back Cover
PARAMAX, INC.	67
Prairie Digital, Inc.	75
R.E. Smith	74
Scott Edwards Electronics, Inc.	81
Square 1 Electronics	27
Technological Arts	92
Vesta Technology, Inc.	73

## Printers/Printer Supplies

H.T. Orr Computer Supplies	62
Inkjet Southwest	44

## DESIGN/ENGINEERING SERVICES

ExpressPCB	26
Midland Technologies	73
Plans-Kits Unlimited	73
Prairie Digital, Inc.	75
Pulsar, Inc.	53
Sky Electronics, Inc.	29
V&V Mach. & Equipment, Inc.	73-75

## EDUCATION

Advanced Educational Systems	88
Electronix Corp.	82
EMAC, Inc.	29

## EVENTS/SHOWS

ACP Super Store	67
SAM Electronics	13

## KITS

Alltronics	64
C & S Sales, Inc.	85
Digital Products Company	73
Earth Computer Technologies	46
Edlie Electronics, Inc.	18
Electronic Goldmine	56
Electronic Products	73
Electronic Rainbow Ind., Inc.	45
EMAC, Inc.	29
Gateway	42
Information Unlimited	38
Inkjet Southwest	44
Jade Products, Inc.	74
Lemon-Pladd, Inc.	65
Miller Engineering	92
Ocean State Electronics	57
Plans-Kits Unlimited	73
Quality Kits	73
Ramsey Electronics, Inc.	59
Scott Edwards Electronics, Inc.	81
SiGEM	73
USI Corp.	25
Velleman	40
Weeder Technologies	61

## LASERS

Information Unlimited	38
Meredith Instruments	41
Resources Un-Ltd.	33
Unicorn Electronics	65

## MISC./SURPLUS

1A Sales	12
All Electronics Corporation	60
Alltech Electronics	16
Aviation Components Corp.	73
Black Feather Electronics	52
Brigar Electronics	83

**FIND**  
what you need ...  
**FAST**  
BY PRODUCT  
OR  
CATEGORY

C and H Sales Company	58
Communications Surplus	73, 75
Cyber-Test Incorporated	39
DeMar Electronics	75
Electronic Goldmine	56
Electronic Rainbow Ind., Inc.	45
EPS	75
Equipment Management Technology	62
Fair Radio Sales Co.	43
Halted Specialties Co.	3
Linear Systems	13
Resources Un-Ltd.	33
Shreve Systems	24
Skycraft Parts & Surplus, Inc.	67
Surplus Traders	74
Unicorn Electronics	65
Viking International	63
Visitec, Inc.	93
Weeder Technologies	61

## PROGRAMMERS

Andromeda Research	76
Electronic Products	73
General Device Instruments	74
Intronics, Inc.	94
M2L Electronics	46
microEngineering Labs	89

## PUBLICATIONS

Antique Radio Classified	75
Netcom	11
Plans-Kits Unlimited	73
R & D Books	35
Square 1 Electronics	27

## RF TRANSMITTERS/RECEIVERS

Abacom Technologies	50
---------------------	----

## ROBOTICS

Lemos International Co., Inc.	41
Lynxmotion, Inc.	76
O.S. Systems	52
PARAMAX, INC.	67
SuperCircuits	36

## SATELLITE

Baylin Publications	53
SiGEM	73
Worldwyde	74

## SECURITY

American Innovations, Inc.	39
American Technologies Network Corp.	94
A.S. Electronics	84
Information Unlimited	38
Lemos International Co., Inc.	41
Matco, Inc.	73, 75
MSC Electronics	75
Norcomm	71
Polaris Industries	43
SuperCircuits	36
Visitec, Inc.	93

## SOLAR EQUIPMENT

Cruising Equipment	77
--------------------	----

## STEPPER MOTORS

Alltronics	64
PARAMAX, INC.	67

## TELEPHONE

Digital Products Company	73
Telulex, Inc.	56
Weeder Technologies	61

## TEST EQUIPMENT

ABC Electronics	39
Alfa Electronics	63
Allison Technology Corp.	74, 82
AST Global Electronics	81
C & S Sales, Inc.	85
C and H Sales Company	58
Circuit Specialists, Inc.	98
Cruising Equipment	77
Davilyn Corp.	15
Digital Products Company	73
DMD Systems Recovery, Inc.	75
EDS	79
Electro Tool, Inc.	87
Equipment Management Technology	62
Glentech, Inc.	74
Graymark	46
Howard Electronic Instruments, Inc.	19
Intronics, Inc.	94
J-Works, Inc.	91
MCM Electronics	31
Metric Equipment Sales, Inc.	84
Optoelectronics	4
Phelps Instruments	82
Pioneer Hill Software	66
Prairie Digital, Inc.	75
R & S Surplus	61
Saelig Company	58
Seabird Technical	75
Sescom, Inc.	73
Telulex, Inc.	56
Western Test Systems	20-21

## TOOLS

C & S Sales, Inc.	85
Electro Tool, Inc.	87
Howard Electronic Instruments, Inc.	19
Lemon-Pladd, Inc.	65
Patco Service, Inc.	91
The RF Connection	38

## WIRE/CABLE & CONNECTORS

Northwest Cable & Connector Co.	86
Roger's Systems Specialist	55
The RF Connection	38



# AMATEUR ROBOTICS

# NOTEBOOK

by Robert Nansel

In April, I attended the Sixth Annual Fire Fighting Home Robot Contest at Trinity College in Hartford, CT. This was my third year at what has become the premiere Amateur Robotics event in this country — three days of hanging with fellow gearheads, attending topnotch seminars, and watching seriously cool robots do their thing. It draws from all over the US and Canada, and places like Thailand, Switzerland, and Israel.

The contest involves an autonomous robot finding and extinguishing a lit candle in a model house in the shortest possible time. All this must be done without the robot touching any walls, getting lost, or knocking the candle over. The model house is an eight-foot-square maze with four "rooms."

The contestants know the floor plan ahead of time, so maze-solving is not needed, but efficient navigation is. All walls are 13 inches high and are painted flat white, while the floor is painted flat black. Each room in the floor plan is equally likely to be selected as the room where the candle will be placed.

As for the robots, the only restrictions are: 1) Robots must operate autonomously (though tethers to stationary computers are allowed); 2) Robots must never exceed 12.25" in any dimension during operation; 3) Robots must operate in a safe manner as determined by the judges; 4) Robots are not allowed to peer over the tops of the walls. There are no weight or materials limits, and no limits on the kinds of sensors that

can be employed.

## Kids Are Welcome

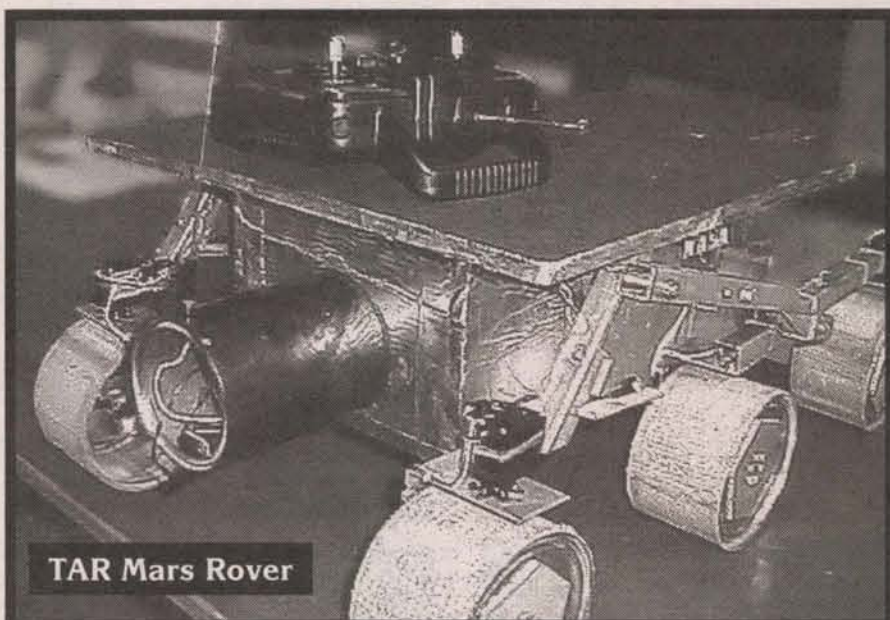
A key part in this contest has always been that there are separate Junior and Senior classes, with equal cash prizes awarded to both: \$1,000.00 for 1st place, \$500.00 for 2nd, \$250.00 for 3rd, \$125.00 for 4th, \$75.00 for 5th, and \$50.00 for 6th. The Junior class is open to all kids up through high schoolers, and even fifth graders have entered competitive robots. The Senior division is for everyone else, from college students to retirees.

A great thing about this contest is the number of robots entered — a number that grows each year.

This year, 73 robots were entered, up from 60 in '98. In the Senior division, there were 41 robots this year, up from 36 robots in '98. Moreover, there were 32 Junior division robots, up a full third from last year's 24 robots.

To achieve a more accurate and just ranking system, the contest organizers have tinkered with the rules over the years. This year, they made a few changes — such as running three mazes at once to make the contest run faster — but they also altered the scoring formula. The scores are still based on the adjusted times for the best two out of three runs, but some score adjustment factors are different this year, so I can't directly compare last year's scores with this year's.

However, at this year's contest, I did get the impression that the cal-



TAR Mars Rover

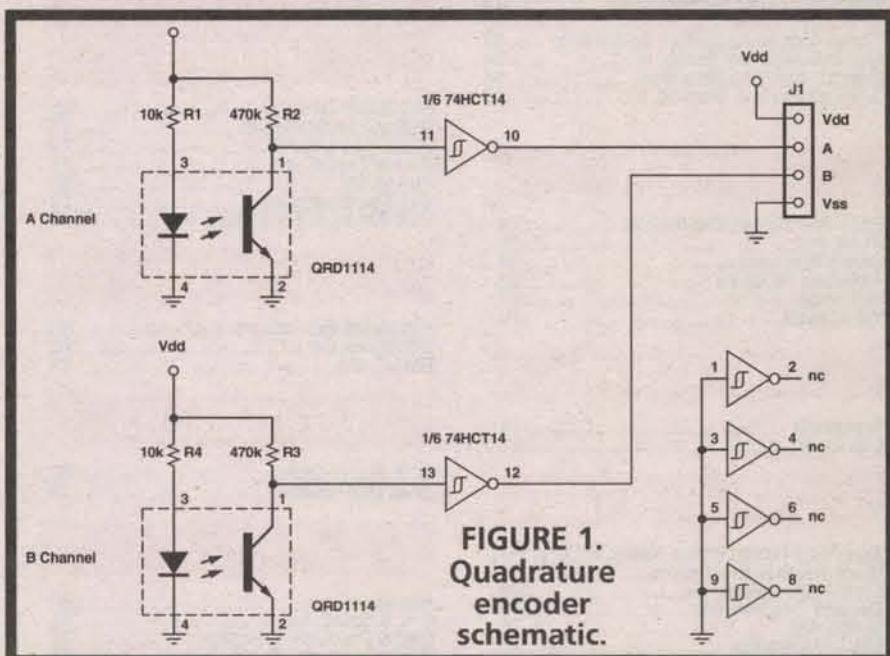


FIGURE 1. Quadrature encoder schematic.

iber of robots competing was higher. Not only were there more robots, they were faster and more reliable in both divisions. The 1st place Junior robot was still slower than the sixth place Senior robot — but not by as much as last year. After pouring over the scores of the last two years, some interesting patterns emerged.

## Junior Robots Rock

The time ratio between 1st and 6th place has narrowed in both divisions. In '98, the Senior 1st place entry was 3.1 times faster than the Senior 6th place. This year, the ratio was 3.0, a small change, but clearly there's still room for improvement in the top. In the Junior division, the ratio was 7.8:1 in '98, but this year it had plummeted to 1.9, meaning the Juniors have proportionally improved much more than the Seniors.

Junior robots are also doing much better relative to the Seniors this year. Last year, the Senior division champ, "Phoenix," was six times faster than the Junior divisions 1st place "Loser's Revenge." This year, the Senior 1st place, "Alexi," was only 4.4 times faster than the Junior 1st place, "Fluffy."

I added up and compared the scores for the top six Senior and Junior division robots for 1998 and 1999. In '98, this aggregate time ratio was 8.9, meaning that the Senior division times were about nine times faster than the Junior; this year, the ratio had dropped to 3.5. Are the kids closing the gap? You bet they are, and in a big way.

## Experience Counts

One thing that jumped out was how important experience was in

## WHOLESALE CABLE

### COMPLETE LINE OF CABLE PRODUCTS

- ☑ Quality merchandise by brand name manufacturers
- ☑ Satisfaction guaranteed ☑ Free gift on first order
- ☑ Technical support
- ☑ 2 year warranty on new converters
- ☑ COD shipping & overnight shipping by request
- ☑ Experience where it counts ☑ Volume pricing

PLAIN CONVERTERS: ZENITH, OAK, PANASONIC, PIONEER, EAGLE, HAMLIN, STARGATE, PLUS MORE.

REMOTE CONTROLS: ALL MAJOR BRANDS, INCLUDING 2-4 FUNCTION UNIVERSAL REMOTES

WHOLESALE CABLE M-F 11am-6pm EST (718) 206-0879  
(718) 262-0900 • FAX (718) 657-4015 • (718) 297-9221

No NY sales. Federal and local laws provide criminal and civil penalties for unauthorized use. Check with your cable providers for permission to use equipment. Must be paying for all services you receive. Order by model number only. Some equipment refurbished as new.

Tell us the best price you were offered, where you got it from, and let us try to beat it.





both divisions. Three of the top six teams had placed in the top six in their divisions in '98. In the Senior division, "Tornado '98" — the product of a team from the Swiss Federal Institute of Technology — placed 2nd both years, while "L.C." by Gary Teachout of the Seattle Robotics Society climbed from 6th last year to 3rd this year. The Trinity College team — always tough competitors — placed 5th this year instead of first as they did last year.

The Junior division had a similar story, but with a twist. In both '98 and '99, three of the top six robots came from one school: Grand River Collegiate in Kitchener, Ontario. The Kitchener crowd has shown up at Trinity year after year and their work is paying off. Both years, they've taken 2nd and 4th. Last year, they took five out of the top nine places. This year, they fielded six teams and took four of the top 10 places. I might speculate about the beginning of a dynasty here, but many of them will no doubt soon graduate from

high school and compete at the Senior level.

## TAR Rover, Come Over

Some of the coolest machines were there only for show. Check out the photo of the TAR Mars Rover, for instance. This is a full-size mockup of Mars Sojourner built by Ken Boone of the Triangle Area Robotics club in Raleigh, NC. The TAR Rover features six-wheel drive and independent four-wheel steering, just like the real thing.

Although it's a radio-controlled machine, it does use a couple microprocessors onboard to translate the radio control signals into separate pulse commands for each of the 10 hobby servos used. Ken has been crafting robots for 35 years and it shows. Be sure to check out his website at <http://users.aol.com/kensrobots/kensrobots.html>.

Another big crowd pleaser was "Stampy," a bipedal robot built by Mark Whitney from Cary, NC.

Stampy walked with a slow, deliberate gait into the maze, found the candle, and put it out, not once but several times. Mark got a special award for this achievement even though Stampy wasn't there to compete. Stampy is not a fast walker and so can't go head-to-head with the other bots. Some folks complained about a lack of innovation in this year's event, but Stampy is ample proof 'taint so.

Then, too, there was Gary Teachout's other robot, T-Cubed, the Table Top Terror. T-Cubed is a 2" by 3" Bot Board with a couple motors and sensors strapped on. It skittered across the table avoiding obstacles and edges. T-Cubed only fell off the table once the whole time of the competition, and only minor damage was done (one of the bumper whiskers got bent).

## Back to Breadbot

Change gears. Last month, I got started on a long-promised project — upgrading Breadbot with shaft encoders for its drive wheels to provide speed and odometry information. I talked a bit about the theory of optical shaft encoders and showed how to make low-cost encoder wheels of various resolutions that work with either Breadbot or the Parallax GrowBot. This month, I'll continue with the project and show how to build the electronics to go along with those encoder disks.

But first, I need to correct an embarrassing error I made last month:

## Egg on My Encoder

The 32-segment encoder disk shown in Figure 2 last month will not give you 128 counts per revolution with quadrature decoding as I stated; the correct number is 64 counts per revolution. That encoder disk has 16 black and 16 white segments, which give an equal number of positive and negative transitions — 32 altogether. Combine this with 32 transitions from a second sensor channel in quadrature, and you get 64 transitions per disk revolution. Not 128.

This error also throws off the maximum frequency the encoder disk will produce when used with a servo. The example servo I used — the Futaba S148 — is rated to slew 60 degrees in 0.22 seconds (0.76 rev/sec). With a 32-segment encoder wheel, the individual sensor channels would produce a maximum raw squarewave frequency of just over 12 Hz; though, in continuous rotation, most Futabas I've tried run closer to 14 Hz. The frequency of transitions is double the squarewave frequency, or about 24 Hz. With a quadrature channel thrown in, a 32-segment wheel then gives an output frequency of double that, or about 48-49 Hz — not 97 as I said. Sorry for the confusion. Really, I can count, folks. Honest.

## Encode This

Warm up your soldering irons. Figure 1 shows the schematic for a simple circuit that does quadrature decoding for last month's encoder disks. The QRD1114 is an inexpensive, compact reflective IR emitter/sensor pair. It's available from Mouser Electronics and Digi-Key, so you shouldn't have any trouble finding it. IC1 is just a plain old 74HCT14 hex Schmitt Trigger. An 'HC14 might work, too, but I haven't tried it. You may have to experiment with the resistor val-

FIGURE 2. Making the encoder disk.

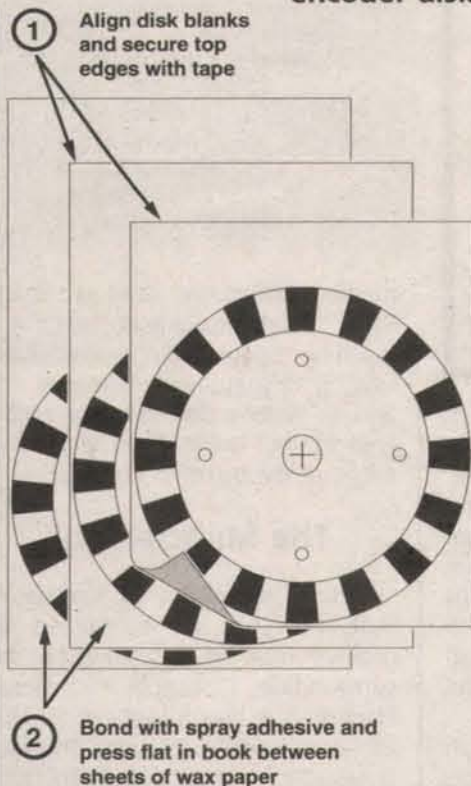
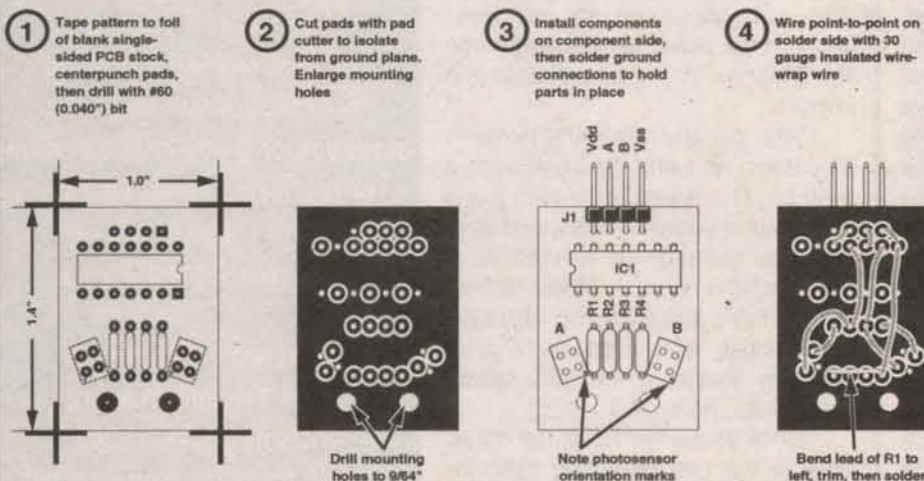


FIGURE 3. Encoder board fabrication.



## D.T.M.F. DECODER

For interconnect and remote control applications

Model NC401

The Model NC401 is a micro-miniature DTMF



decoder, designed for selective control of local or remote applications. Measuring .80"Wx1.37"Lx.23"H, the NC401 combines three distinct, multi-addressing decoders offering multiple user-configurable functions. All programmed features are stored in non-volatile E2PROM memory and are easily programmed by means of a conventional DTMF encoder or the Model NC500 Universal/P.C. programmer. This highly engineered decoder is ideal for portable radio applications having limited space for accessories. The NC401 comes complete with micro-miniature 14 pin header and 12" color coded cable assembly.

\$59.95

Nor-fax Doc. #5545

## VOICE SECURITY ENCRYPTION

Model NC802

The Model NC802 is a miniature inversion scrambler designed to provide intermediate level security for two-way radio



voice communication systems and is a perfect, cost-effective solution to entry-level voice scrambling as a defense against unauthorized or casual listeners. The NC802 provides eight user selectable carrier codes commonly used by other manufacturers and interfaces easily to most radios with near transparency to the user.

\$59.95

Nor-fax Doc. #5759

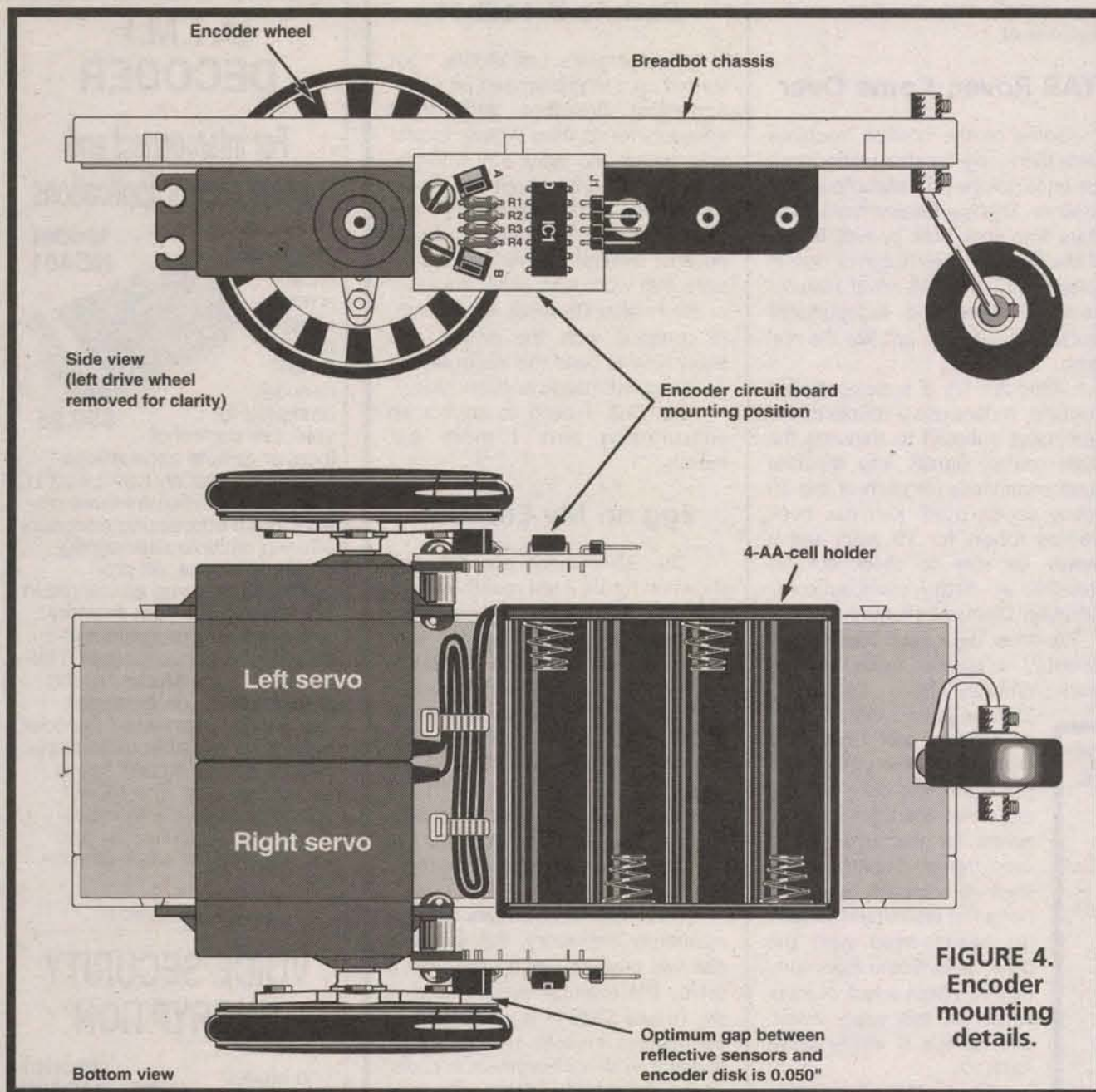
For Detailed Specifications or Product Catalog call our 24-Hour NorFax retrieval system at 530-477-8403 or on our Web Site at [www.norcommcorp.com](http://www.norcommcorp.com)



800-874-8663

15385 Carrie Drive  
Grass Valley, CA 95949 USA





**FIGURE 4.**  
Encoder  
mounting  
details.

ues anyway, depending on the paper and toner used to reproduce the disks. -

*Mobile Robotics* by Jones & Flynn suggests using blank disks of paper behind your encoder pattern to ensure that enough IR is reflected from the white segments back to your sensor. With my disks, though, I ran into the opposite problem: too much IR reflected from the black segments.

I tried increasing the values of R1 and R4 in order to cut the intensity of the IR emitters, but then the signal was too weak. Increasing the size of R2 and R3 increased the sensitivity of the sensors, but now the circuit became squirrely and far too sensitive to ambient light conditions — a fatal flaw in an unenclosed encoder.

I was finally forced to resort to the technique of gluing together a stack of identical copies of the encoder pattern (see Figure 2). If I make the IR emitters strong enough to drown out ambient room lighting, the toner from my laser printer isn't dense enough to prevent some of that IR from reflecting from the paper behind the first disk. Stacking black on black and white on white solved the problem. I used 3M Super 77 spray adhesive.

## A Prototype for All Seasons

Figure 3 shows a circuit board with sensor geometry intended for use with the 32-segment encoder disk. I intend to make a reasonably-priced printed circuit board available for this decoder circuit if there is enough interest but, for prototype purposes, it was easier to use the hybrid point-to-point technique shown.

Normally, I prototype with perf-board but, in this case, I needed to control the precise angular separation and orientation of the sensors. For a 32-segment encoder disk, the sensors must have an angular separation of 39.4 degrees. Also, the sensors must be oriented so that the encoder segments cut across the optical axis of the sensors at right angles. I could have drilled special holes in perfboard for the sensors, but getting the extra holes drilled to the accuracy required would have been quite tricky.

Instead, I used bare copper-clad stock so I could drill holes with any spacing and pattern I wished and a paper pattern to show me where the holes should go. I drew the pattern

with a CAD program and printed it out on my laser printer — one pattern for each board I wanted to make. You can do the same thing, or you can photocopy the pattern in Figure 3. If you do photocopies, be sure your copies match the dimensions shown in Step 1 of the figure. The Step 1 pattern gives the locations of the hole locations as seen from the copper side of the circuit board.

Securely tape the patterns to an oversized piece of copper-clad stock, then use a prick punch to precisely locate and lightly punch the location of each hole. When you are done punching, use a metal straight edge and a hobby knife to cut right through the paper pattern and scribe the outlines of the board onto the copper.

Strip off any remaining portions of pattern and drill the holes with a # 60 bit. This is best done with a drill press but, if you use high-speed steel bits, you can manage it freehand if you are very careful. With carbide bits, though, a drill press is absolutely essential, and even then you'll probably shatter a few bits before you get the hang of it.

Once you've drilled all the holes, enlarge the two mounting holes by step drilling with one or two inter-

## Fire Fighting Home Robot Contest

Jake Mendelsohn  
190 Mohegan Drive  
West Hartford, CT 06117  
jmendel141@aol.com  
www.trincoll.edu/~robot

## Digi-Key Corp.

701 Brooks Ave. South  
Thief River Falls, MN 56701-0677  
tel: 1-800-344-4539  
1-218-681-6674  
fax: 1-218-681-3380  
www.digikey.com

## Ken's Robots: Small Systems Design and Fabrication

KD4JMK  
tel: 1-919-596-1161  
kensrobots@aol.com  
http://users.aol.com/kensrobots/kensrobots.html

## Mobile Robots: Inspiration to Implementation, 2nd Edition

Joseph L. Jones, Anita M. Flynn,  
and Bruce Seiger  
ISBN 1-56881-097-0  
A K Peters, Ltd.  
63 South Ave.  
Natick, MA 01760  
tel: 1-508-655-9933  
fax: 1-508-655-5847  
www.akpeters.com

## Mouser Electronics

958 N. Main  
Mansfield, TX 76063-4827  
tel: 1-800-346-6873  
1-817-483-6848  
fax: 1-817-483-6899  
www.mouser.com

mediate drillbit sizes until you reach 9/64", the clearance hole size for # 6 machine screws. Cut each board roughly to shape with a Dremel drill and an abrasive disk using the scribe lines as your guide. Sand or file the edges of the board to final size.

## The Miracle Tool

Next, the nodes of the circuit that aren't to be connected to ground must be isolated from the surrounding copper. Vector Electronics makes a tool just for this job — the P138A pad cutter. This tool is available for about \$20.00 US from Digi-Key, Mouser, and others, and no robot builder should be without one.

With this hand tool, you make

As always, if you have suggestions for improving Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

## Robert Nansel

69 S. Fremont Ave. #2  
Pittsburgh, PA 15202

E-Mail: bnansel@nauticom.net





## GPS Design Kit — \$379

The design kit SGMS600KS is a complete and immediately usable means of evaluating the SIGEM GPS receiver module and high performance GPS antenna, which are included in the kit. Software running on the GPS receiver module communicates to a user supplied computer via NMEA 0183 formatted messages. Advanced PC software provides map integration and a demonstration of tracking. Provision has been made for DGPS inputs.

SIGEM Inc.  
50 Hines Road  
Kanata, Ontario  
Canada K2K 2M5  
Tel: (613) 271-1901 (Can)  
(541) 923-3733 (USA)  
Fax: (613) 271-1996

**SIGEM**

Web: [www.sigem.ca](http://www.sigem.ca)  
Email: [info@sigem.ca](mailto:info@sigem.ca)

## PCBs

PER SQIN  
**\$100.00 SETUP**  
WE SPECIALIZE IN SINGLE SIDED, 1 OZ, PC75

**9¢**

## PCB LAYOUT

PER COMPONENT PIN **\$100.00 MINIMUM**

**59¢**

## ENGINEERING DIAGRAMS

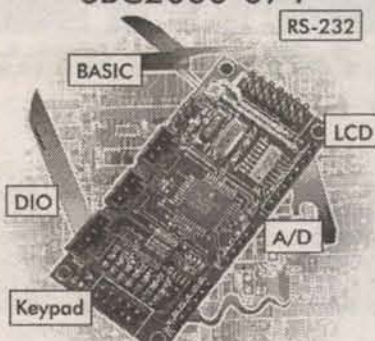
PER COMPONENT PIN **\$100.00 MINIMUM**

**39¢**

V&V MACH. & EQUIP., INC. (HOUSTON, TX OFFICE)  
PH (281) 397-8101 FAX (281) 397-6220  
MARKETING TECH. S.A. (MEXICO/PLANT)  
PH 011 (525) 361-3351 FAX 011 (525) 361-5996

## SBC2000-074

RS-232

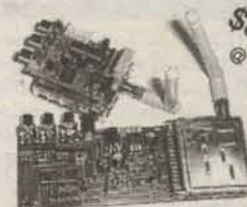


Versatility starting at \$64 each.

Voice: 303.422.8088 Fax: 303.422.9800  
[www.sbc2000.com](http://www.sbc2000.com)

Vesta Technology, Inc.

## 2.4 GHz Wireless Transmitter & Receiver



**\$89/pair**  
@ 50 pcs

2.4 GHz ~ 2.48 GHz User Selectable  
Over 700' Range and 4 Chl Auto-scan  
NTSC, PAL, Composite video B/W or Color  
2 Audio Inputs may be used for digital data  
Customizations including battery packs  
and Special Frequencies

**Matco Inc.**

(800)440-0299 or (800)719-9605  
[www.mat-co.com](http://www.mat-co.com)

## Telecom Hardware/Software Developers

STOP using your phone lines to test and demonstrate your telecom devices. Our affordable telephone line simulators offer authentic USA dial tone, busy signals, ringing, and exceptional speech quality.



### RING-IT! TELCO SIMULATOR

- Single Line (two RJ-11 Jacks)
- LED Display
- DTMF Operation
- Automatic Ring-up Mode
- **\$325** (\$149 kit available)

### PARTY-LINE TELCO SIMULATOR

- Six Extensions
- Caller-ID (Name/Nbr)
- Distinctive Ringing
- **\$425** (\$199.95 kit avail)



Digital Products  
**COMPANY**

134 Windstar Circle  
Folsom, CA 95630 USA  
Tel: 916-985-7219  
Fax: 916-985-8460



<http://www.digitalproductsco.com>

## NEW 3 AMAZING NEW PRODUCTS

### 12-HOUR VOICE ACTIVATED MULTI RECORDER MC-4



- CAN BE USED AS:
1. ROOM MONITOR
  2. TEL. LINE RECORDER
  3. MULTI-LINE HANDSET RECORDER
  4. REGULAR 12-HOUR RECORDER

**\$95**

INCLUDING SHIPPING



### THE PRIVACY ENFORCER

- STOPS
1. VOICE ACTIVATED AND VOLTAGE SEN TELEPHONE RECORDERS
  2. ALERTS YOU WHEN SOMEONE ELSE IS LISTENING IN FROM ANOTHER EXTENSION

**\$49**

INCLUDING SHIPPING



### THE BUG BUSTER

1. DETECTS AND LOCATES FM TRANSMITTERS (BUGS)

**\$79**

INCLUDING SHIPPING

CALL 1-905-820-8020

## PC BOARD SERVICES

PCB Design Layout  
Thru Hole  
SMT  
Multilayer

PCB FABRICATION  
In-house Prototypes  
Single and Double Side  
Plate Thru Hole

ASSEMBLY  
Thru Hole  
Small Project Specialists

Serving Engineers and Hobbyists  
for 16 Years

**MIDLAND TECHNOLOGIES**  
800-726-8871 Voice  
406-586-0300 FAX

## VIDEO CHARACTER OVERLAY GENERATOR

New **BOB-II** superimposes up to 308 characters on standard video or generates video. 30-pin SIMM design, RS-232 interface, easy to use for:

Video Inspection - NDT  
Home Automation Display  
ATV - CCTV Security - CATV  
Remotely Piloted Vehicles  
Gaming - Racing - Sports  
Process/Experiment Monitor  
Robotics - Electronic Signs

Single units only \$79.95

## DECADE ENGINEERING

5504 ValView Dr. SE, Turner, OR 97392  
Tel: 503.743.3194 - Fax: 503.743.2095  
[mikeh@decadenet.com](mailto:mikeh@decadenet.com) - [www.decadenet.com](http://www.decadenet.com)

## GPS Antennas

Magnet Mount Antenna  
+28 db gain  
**\$54.95**

Trimble Placer 300  
Unit with built in Antenna  
**\$89.95**

Trimble Magnet Mount  
+ 30 db gain  
**\$69.95**

## Communications Surplus

713-526-8000 or 1-877-878-6GPS  
[Ishaefer@flash.net](mailto:Ishaefer@flash.net) Fax to 713-522-6309

## New!

### ActiveWire™USB Simple USB Interface



- Internet Browser Script-able
- 24 MHz CPU core with USB
- Firmware downloadable via USB
- 16 bit parallel I/O
- Expandable add-on boards
- New firmware and scripts available from website

**\$59** plus shipping  
**ActiveWire, Inc.**

[www.activewireinc.com](http://www.activewireinc.com)

ph(650) 493-8700 fx(650) 493-2200

## QUALITY KITS

### #1 Source for Electronic Kits

Great selection of Hi-Fi AUDIO Kits, PSUs, Transmitters, Oscilloscopes, PIC Programmers, and much more.

Toll Free Order Line:

**1-888-464-5487**

Secure On-Line Ordering  
**[www.qkits.com](http://www.qkits.com)**

Call 613-544-6333 for free catalog  
**North American Kit Distributor**  
49 McMichael St., Kingston, ON  
K7M 1M8, CANADA

## Aviation Components Corp.

28 Hunting Hills Drive  
Landenberg, PA 19350

We buy and sell:

- Relays
- Switches
- RF Components
- All MIL-SPEC
- Electro-Mechanical Devices
- Resistors
- Circuit Breakers
- Semiconductors
- ICs

Home Office (sales)

610-255-3761 • FAX 610-255-3548

Morrisville Office (purchasing)

215-295-3507 • FAX 215-295-8633

E-Mail: [aviationcomp@earthlink.net](mailto:aviationcomp@earthlink.net)

For more info check out our website:

<http://home.earthlink.net/~aviationcomp/>

## Program PICs in Basic Complete kit to get started!

**\$115.95**



Includes:  
Compiler, Programmer, PIC, Cable & Batteries

ORDER



## Electronic Products

(248) 515-4264 Fax: (413) 825-0377

[www.elproducts.com](http://www.elproducts.com)

**NEED BATTERIES!!**  
**[batterystore.com](http://batterystore.com)**

TNR Technical, Inc.  
301 Central Park Drive  
Sanford, FL 32771  
1-800-346-0601

## Plans-Kits Unlimited

PLANS KITS PARTS OVER 120,000 PLANS

LASERS MASERS EMP TESLA  
RAIL & COIL GUNS JAMMERS  
ULTRASONICS HIGH VOLTAGE  
PLASMA & ION GUNS HERF  
MIND CONTROL NUCLEAR  
PHREAKING BIO-ELECTRONIC

IF WE DON'T HAVE IT, WE'LL GET IT.

<http://www.plans-kits.com>

AD SPECIAL!!! RUBY & SAPPHIRE SURPLUS RODS  
FOR HIGH POWER CUTTING LASERS. 1/8" x 3" L.  
FLAT ENDS, MATTE FINISHED, SURPLUS MILITARY.  
\$12.00+\$15/M EA. CHECKS, CASH, MONEY ORDER.

PLANS-KITS UNLIMITED: (BASE FOR CATALOG)  
1839-D WEST VISTA WAY #515, VISTA CA 92083

GREAT  
FOR TEST FIXTURE  
BUILDING



**LAB-1**  
(1.5" x 2.0" x 0.75")

## FREE!

PHONE, FAX, WRITE  
OR E-MAIL WITH YOUR  
MAILING ADDRESS  
MUST MENTION  
OFFER "LAB199"

PRE-PUNCHED END PANELS  
ALSO AVAILABLE  
8 BOX SIZES  
25 PREPUNCHED  
END PANELS

ALSO IN STOCK AT:  
JENSEN TOOLS: 800-436-1194  
MCM ELECTRONICS: 800-543-4330  
TECH AMERICA: 800-442-7271

ALL ALUMINUM CONSTRUCTION LOW COST  
OFFER GOOD ONLY IN THE 48 STATES ENDS DECEMBER 30, 1999. LIMIT ONE  
REQUEST PER CUSTOMER. MAILED 1ST CLASS. ALLOW 1-2 WEEKS FOR DELIVERY



ORDERS 800-834-3457 • FAX 800-551-2749  
OFFICE 702-565-3400 • FAX 702-565-4828  
[www.sescom.com](http://www.sescom.com) • [info@sescom.com](mailto:info@sescom.com)

SESCOM, INC. 2100 WARD DR. HENDERSON, NV 89015

SESCOM, INC. is not responsible for printing and typographical errors  
and prices and specifications are subject to change without notice.



## A/D CONVERTERS with SERIAL OUTPUT

Tiny (1.75"x1.41") fully assembled and tested printed circuit board includes two 8-bit A/D converters and one digital input. Up to 16 units addressable (DIP switch setting) totalling 32 converters on a single serial port. Output is ASCII encoded bit count (0 to 255) at 2400 BPS via RJ-11 interface. Fully programmed PIC16C71 installed in IC socket. Sample software in BASIC included. Requires 8-28Vdc At 1-2mA.

\*\$49.95. Optional

DC adapter \$19.95.

Add \$5.00 shipping.



Tele: 847-891-2584

Fax: 847-891-2587

www.glentech-rf.com

## SURPLUS SALE

### 1,000,000 WALL TRANSFORMERS



3VDC/100MA	....	CX099	....	\$0.75
6VDC/100MA	....	CS039	....	\$1.45
9VDC/100MA	....	CR314	....	\$1.45
12VDC/200MA	....	CS033	....	\$0.99
13.5VAC/400MA	....	CR574	....	\$1.29
24VDC/500MA	....	CR174	....	\$3.40

Min 1000/type - Call for other types

## SURPLUS TRADERS

PO Box 276,

Albany, VT 05440

Tel: (01) 514-739-9328

Fax: (01) 514-345-8303

http://www.73.com/w

**FREE CATALOG!**

## PROGRAMMERS

ADVANTECH EETOOLS NEEDHAM DATA I/O ICE TECHNOLOGY HILO SYSTEM GENERAL CHROMA MODULAR CIRCUIT TECHNOLOGY XELTEK



PROMAX EMP-20 MEGAMAX MEGAMAX4 SIMM/SIP TESTER EMUPA  
CALL ADVANTECH LABTOOL 629 ICE TECH MICROV 650 EETOOLS ALLMAX + 409 EETOOLS MEGAMAX 509 EETOOLS MEGAMAX4 369 XELTEK SUPERPRO II 409 XELTEK SUPERPRO II P 249 XELTEK SUPERPRO L 165 XELTEK ROMMASTER II 479 MOD-MCT-EMUPA 739 STAG ORBIT-32  
599 EETOOLS SIMMAX 795 CHROMA SIMM/SIP 359 MOD-MCT-EMUPA/R 279 MOD-MCT-EMUPA/R 49 EPROM 1G TO 512K 69 EPROM 1G TO 1MEG 99 EPROM 4G TO 1MEG 199 EPROM 16G TO 1MEG 89 EPROM 1G TO 8MEG 129 EPROM 4G TO 8MEG 250 EPROM 8G TO 8MEG



LABTOOL48 MICROMASTER SUPERPRO ALLMAX PLUS ROMMASTER2

**General Device Instruments**  
Sales 916-393-1655 Fax 916-392-4949  
Web www.generaldevice.com E-Mail lodevice@best.com

## BATTERY — YUASA



Sealed Lead-Acid/Gel-Cell  
12V: 7AH \$19, 2.3/4AH \$16  
18AH \$39, 1.2AH \$13  
6V: 4AH \$9, 10AH \$13

Quantity Discounts Available  
Call for other models

## Aventrade

4518 Temple City Blvd., Temple City, CA 91780  
Tel. 626-286-0118 Fax 626-287-9618

E-Mail: sales@aventrade.com  
www.aventrade.com

## Serial Port Problems ???

No heavy, aging serial protocol analyzer available? Use **Serial** to turn your PC into a test tool for asynchronous serial communications. **Serial** uses your PC serial ports to capture data, control and time stamps to give you what's needed to develop or debug your serial communications.

- Captures Data & Control lines
- Autobaud Detect
- Millisecond Timing
- Extensive Manual
- Contextual Help
- Block Transmit
- Trigger Strings
- Full Duplex Monitoring

Serial with manual US\$99.00  
Full Duplex monitor cable US\$40.00

Allison Technology Corporation

2006 Finney Villet Rd., Rosenberg, TX 77471

800-980-9806 or 281-239-8500, Fax 281-239-8006

http://www.atcweb.com atc@accesscomm.net

## JUNE SPECIAL SAVE \$10.00

### SHIELDED LOOP RECEIVER

30M, 40M KITS W/ ANTENNA.

VERY SENSITIVE. HAS HIGH

IMMUNITY TO QRN & LOCAL

AM BROADCAST. \$92.50 PP

### 12/14V PULSE BATTERY TESTER

(LEAD ACID). ATTACH THE BATTERY &

PUSH THE BUTTON TO DETERMINE IF THE

BATTERY NEEDS RECHARGING. A MUST

FOR THE GLIDDER SET, BOATERS, ETC.

BASIC KIT \$55.50 PP

ASSEMBLED WITH ENCLOSURE \$106.50 PP

### MARCONI ANTENNA 700W 50 Ω

THE BEST "LITTLE" LOW BAND ANTENNA

80M: 67' OVERALL \$47.45 PP

160M: 130' OVERALL \$54.45 PP

### CODE PRACTICE OSCILLATOR... \$23.45 PP

SEND FOR FREE CATALOG

1-800 JADE PRO (523-3776)

www.jadeprod.com/

email: jadeprod@jadeprod.com

JADE PRODUCTS E. HAMPSTEAD NH 03826-0368

## CABLE SECRETS!!!

This ad has been  
**CENSORED!**

Want to know why?

Visit us at <http://www.worldwyde.com>

- Find out how "Test" Devices work
- Installation of "Test" Devices
- Descrambling Methods Explained
- Detailed Construction of "Test" Devices

Includes plans and source code

Complete source code ..... \$79.95

Code for individual boxes ..... \$29.95

## DSS SECRETS — Vol. 2

Instructions on programming DSS access

cards. This is the most current information

on the market! Includes software, plans, and

hardware sources. Book & CD-ROM.

Get this before they censor it too!!!

DSS Secrets Vol. 2 ..... \$49.95

VISA • MasterCard • American Express

To order, call Worldwyde • 1-800-773-6698

21365 Randall Street • Farmington Hills, MI 48336

Visit us on the web at [www.worldwyde.com](http://www.worldwyde.com)

## Build Your Electronics Library At A Price You Can Afford!

Check out the  
**HOT DEALS** at the  
**Nuts & Volts Bookstore!!**  
(See ad page 9.)

As a paid subscriber, you'll  
get 10% off the listed price!!

## TV 85 PJ & TV 86 CABLE CONVERTERS VOLUME & NON-VOLUME CONTROL

SALES/SERVICE  
VOICE 1-800-473-0506  
FAX 1-800-488-0525

**FOSS  
WAREHOUSE  
DISTRIBUTORS**  
285 Schenck St.  
N. Tonawanda, NY 14120  
[www.fossw.com](http://www.fossw.com)

## CUSTOM PLASTIC PARTS

- MODELS (WOOD AND RESIN). TO EVALUATE YOUR PARTS BEFORE COMMITTING TO MANUFACTURE A MOLD.
- MOLD DESIGN AND BUILDING.



- PRODUCTION OF INJECTION MOLDED PARTS. NO ORDER TO SMALL OR TO BIG.
- VERY COMPETITIVE ON HIGH LABOR PARTS.



We also have manual low pressure machines for injection molding of very small runs or prototypes of parts up to 2 oz. At a surprisingly low price.

USA. Office: V&V Mach. And Equip. Inc.

Tel. (218) 397-8101, Fax (218) 397-8220.

Please send blue prints or samples to:

Marketing Tech. S.A. • Alamo 93, 4 Piso • Sta. Monica,

Tlax • Eco. De Mexico 54040 • Tel. 011 (525) 36' -3351.

Fax 011 (525) 361-5996. AT • N. VICTOR M. MENDOZA

e-mail: marktech@infocel.net.mx

## PCB's in Minutes From LaserPrint! \*

8 1/2" x 11" Sheets

- Or Photocopier
- Use household iron to apply.



## PnP BLUE or PnP WET

For High Precision Professional PCB Layouts

Easy Hobby Quality PCB's

1. LaserPrint
2. Iron-On
3. Peel-Off
4. Etch

1. LaserPrint
2. Iron-On
3. Soak-Off w/ Water
4. Etch

Adds an Extra Layer of Resist for Super Fine Lines on Std. Clad Bds.

Transfers Laser Printer or Copier Toner as Resist to Std. Clad Bds.

20Sh \$30/40Sh \$50/100Sh \$100 Blue/Wet (No Mix)

Sample Pack 5 Shs Blue + 5 Shs Wet \$20

VISA/MC/PO/CH/MO \$4 S&H -- 2nd Day Mail

Techniks Inc. P.O. Box 463 Ringoes NJ 08551

(908) 788-8249

100% Money Back Guarantee-Dealer Inquiries Invited

## Convert RS-232 to RS-485 or TTL/CMOS for Only \$49.00

Communicate up to 4,000 feet, at up to 1 MEGA-BPS, full or half duplex, up to 32 units on one serial link, with 31 jumper options for flexible configuration, LED indicators.



## COMMUNICATIONS CONVERTER

- FULL SCHEMATIC AND DOCUMENTATION
- FULL FAMILY OF MODULAR DESIGNS
- RS-485/RS-422 REMOTE I/O MODULE KITS
- NETWORK SOFTWARE AND SOURCE CODE
- AUTOMATIC OR RTS UNITS AVAILABLE
- RJ-11/12 CONNECTORS OR TERMINAL STRIP
- TURN YOUR PC INTO A DISTRIBUTED DATA ACQUISITION AND CONTROL SYSTEM

## R.E. SMITH

(513) 874-4796

4311 TYLERSVILLE RD. • HAMILTON, OHIO 45011

[www.rs485.com](http://www.rs485.com)

your own isolated circuit board pads. Just insert the pilot pin in a hole where you want a pad, press in until the teeth of the shank bite into the copper, and give the tool a couple turns until you've created an insulating mote between the pad and the rest of the board. For holes spaced on 0.1" centers, the cutter will take a tiny bite out of the adjacent pads, but don't worry about it. There will still be plenty of pad to solder to.

Step three is to install the components. Bend the leads of the resistors so they won't fall out as you handle the board, then bend the lead of R1 nearest the mounting hole so it lays flush with the board and touches the leads of R2 through R4; solder

these leads and clip close to the solder joints.

Pay special attention to the orientation of the reflective sensors: pin 1 is marked by a dot on the top side of the plastic case. You can hold these and other components in place with masking tape on the component side until they are securely soldered in at least two places.

Start with the ground connections. You'll need a fairly hot soldering iron because the copper ground plane will soak up a lot of heat before it will take solder. I recommend using rosin paste flux to make the job easier. Just dab a little flux around the pin to be soldered; you'll be amazed how much easier the

joint is to make then. Don't use too much solder for these ground plane connections, though, because it's easy to make inadvertent solder bridges to adjacent pads.

The fourth step is to wire up the remaining nodes of the circuit. This is done with 30 gauge insulated wire-wrap wire. Do the shorter wires first. Strip an eighth inch of insulation off one end, then lay the wire out between the two points to be connected following the wiring diagram. Snip off the other end an eighth inch beyond the second pin, then strip that end. Crimp the bare wire end around the pin and solder. Wait to solder pins that have more than one wire to be connected until all needed

wires have been crimped to that pin.

It's best to do continuity checks with a meter as you make each connection. Check that the two pins being connected actually have continuity, check that you haven't accidentally bridged to ground, and also check that you haven't shorted to adjacent pins. A good way to keep track of your checks is to highlight them on the schematic as you make each check.

Once you are satisfied that all of the connections are correct, do a continuity test between ground and the pins of the connector. Only the ground pin should show low resistance. If the circuit has passed all these tests, it's safe to apply five volts



## EMBEDDED DOS Flashlite-V25

- 2 Serial Ports
- 2 DMA Channels
- 2 Timer Channels
- 20 Parallel I/O Lines
- 5 Volt Operation
- 4 Hardware Interrupts
- 8 Analog Comparators
- Low Power Consumption



qty 1 \$119  
qty 100 \$99  
qty 1000 \$65

### Development Kit - \$159 Includes:

- Flashlite V25, 10MHz, 512K Ram/ 512K Flash
- Borland C/C++ 4.52 Development Software on CD
- Telecommunications Program & Sample Programs
- AC Adapter and Cables

www.jkmicro.com  
Call 530-297-6073 Fax 530-297-6074

**JK microsystems**

## VIDEO PRODUCTS



CNL-100 \$49 BX-120-P \$59 SX-800 \$79

- 430 TV Lines Resolution
- 9-14 VDC Operation
- Infrared Sensitive
- SX-800 has Audio Output
- A-300 Camera Enclosure also available

### MATCO, INC.

Schaumburg, IL  
1-800-719-9605 • 1-847-619-0852 FAX  
E-Mail - info@matco.com  
Website - www.matco.com

## 10&14 Hour Telephone Recorders



Starting at \$69 +\$6.95 S/H  
Times based on a 180 tape  
14 Hour \$89+S/H  
120 Tape included!

Automatically starts recording when the phone is picked up and stops when you hang up. Records both sides of the conversation!  
Printed catalog \$3 (free with order)

Visit our Online Catalog  
www.mscelectronics.com  
MSC Electronics  
PO BOX 461 Jessup, MD 20794  
(301) 497-1600  
FAX (301) 497-1925  
No Checks • US & Canada Only

## EPS EPROMS AS LOW AS 25¢

27C256	27C040	27C1024	87C51
27C512	27C400	28F010	8751
2732A	27C4096	28F020	8755
27C32	574000	28F040	MC68HC70
27C128	574200	8749H	5C8A
27C84	27C402	8748H	PIC16C56
2716	27C020	8741	PIC16C54
2708	27C210	8742	PIC16C22
27C512-90	27C010	8744	GAL16V8

STATIC RAM  
HM628128  
62256  
6264  
6116

PROCESSOR  
8255  
8254  
80C31

• Many more parts in stock  
• All major brands  
• All guaranteed  
• E-Mail: eproms@aol.com

TEL: (818) 774-9444 • FAX: (818) 774-0822  
**WE BUY EXCESS INVENTORY**

## FREE SAMPLE COPY! ANTIQUE RADIO CLASSIFIED

Antique Radio's Leading  
Monthly Magazine  
Articles - Classifieds - Ads for Parts & Services. Also: Ham Equip. - Books - Telegraph - 40's, 50's & 60's Radios - Early TV - Auction Reports & more...  
1-Year: \$39.49 (\$57.95 by 1st Class)  
6-Month Trial - \$19.95. Foreign - Write.  
A.R.C., P.O. Box 802-G23  
Carlisle, MA 01741  
Call: 978-371-0512 - Fax: 978-371-7129  
Web: www.antiqueradio.com

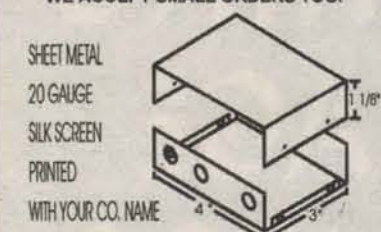
## TOGGLE SWITCHES - All sizes and types Commercial Quality

TYPE	MODEL	RATING	LEAD	100-1000
SPST	D125	6A/125V	6" wire	.77 .67
SPST	D128	4A/125V	Solder	.57 .47
DPDT	D126	5A/125V	Solder	.77 .67
DPDT	D127	10A/125V	Solder	1.17 1.06
on-off-on		5A/250V	Screw	
MINIATURE TOGGLE SWITCHES 1/4" DIA.				
SPST	D131	6A/125V	Solder	.57 .47
SPDT	D132	6A/125V	Solder	.61 .51
SPDT	D129	6A/125V	Solder	.77 .67
mom-off-mom		3A/250V	Solder	
SPDT	D134	6A/125V	Solder	.77 .67
on-off-on		3A/250V	Solder	
DPDT	D133	6A/125V	Solder	.77 .67
DPDT	D135	6A/125V	Solder	.92 .82
on-off-on		3A/250V	Solder	
DPDT	D130	6A/125V	Solder	.92 .82
mom-off-mom		3A/250V	Solder	
MOMENTARY PUSHBUTTON SWITCHES 1/4" DIA.				
SPST	Nor Open DM1	3A/125V	Solder	.30 .25
SPST	Nor Close DM2	3A/125V	Solder	.30 .25

ANY ORDERS LESS THAN 100, ADD 20¢ EACH  
LEDs Red, Yellow, Green - \$12.00/100 \$10.00/1,000  
DEMAR ELECTRONICS  
P.O. Box 7215, Algonquin, IL 60102  
Toll Free 877-655-6433  
Fax 847-854-4434

## CABLE BOXES

CUT MANUFACTURING COST!  
WE ACCEPT SMALL ORDERS TOO.



ALSO PCB, SMT, PROTOTYPES, ASSEMBLY,  
PLASTIC MOLDS, INJECTION MOLDING.  
USA Office: V&V Mach. & Equipment, Inc.  
Ph: (281) 397-8101, Fax: (281) 397-6220.  
Mexico Plant: Marketing Tech.  
Ph: 011 (525) 361-3351, Fax: 011 (525) 361-5996.

## GPS Units

Trimble Placer 400  
6 Channel & Magnet Mt. Antenna  
\$79.95  
Trimble SVecSix  
6 Chan w/ Diff. & Magnet Mt. Antenna  
\$89.95  
Rockwell MicroTracker LP  
5 Channel, Module w/ Differential  
& Mag. Mt. Antenna \$89.95  
Communications Surplus  
713-526-8000 or 1-877-878-6GPS  
lshaefer@flash.net Fax to 713-522-6309

## ASSEMBLY & ENGINEERING

Producible designs since 1970  
Contract Engineering  
Embedded Microprocessors  
PCB Layout and Packaging Design  
Analog Including RF to 1 GHz  
Instrumentation  
A/D and D/A  
Contract Assembly  
High-Speed Fuji Surface Mount  
Through hole  
Turn-key or Kit  
Run sizes one through thousands  
Test and burn-in available  
Bilocon Corp.  
800-736-5927  
425-353-2276  
www.bilocon.com

Stereo Microscopes  
-10X & 30X  
-Top and bottom  
Light  
-Dust cover  
-Eyeguards  
-1 year warranty  
ST241A - \$275.00  
Catalog available  
jlittle@netwizards.  
3580 Haven Ave. Redwood City, CA 94063-  
4603 650/367-8320 Fax 365-5845

## CONTROL • MEASURE • INPUT

MODEL 40-\$109  
• RS-232 interface  
• 28 lines digital I/O  
• Eight analog inputs  
• PWM output  
• Three stepper ports  
MODEL 100-\$279  
• 12-bit 100KHz A/D • Four analog outputs  
• Three timer counters • 24 digital I/O  
PRAIRIE DIGITAL, INC.  
920 SEVENTEENTH ST., INDUSTRIAL PARK  
PRAIRIE DU SAC, WI 53578  
TEL: (608) 643-8599 • FAX: (608) 643-6754

the only place  
to go for  
computer &  
dmdsystems.com  
test equipment parts,  
spares, systems  
and components  
DMD SYSTEMS RECOVERY, INC.  
602 305-8485  
fax 602 305 8490 • email info@dmdsystems.com

to the Vdd and ground to the Vss pins. Use an oscilloscope or a logic probe to check the output levels of the "A" and "B" pins as you bring a few sheets' thickness of plain white paper near each sensor in turn. You should see a crisp 0 to 1 logic transition when you bring the paper close, and an equally crisp 1 to 0 transition when you remove the paper. Under fluorescent lights, you may see a 120 Hz pulse train coming from the sensors, but these pulses should disappear when you shield the board from direct fluorescent light.  
Mount the boards to the servos as shown in Figure 4. The boards mount on 0.25" aluminum standoffs with 1/16" thick fiber washers to

shim the boards out to get 0.050" gaps between sensors and encoder disks. If you don't have calipers to measure the gaps, you can use an ordinary automotive feeler gauge to set the distance.  
**It Works, Right?**  
When everything is aligned you should be able to see two (hopefully) squarewave signals on your scope. They should be 90 degrees out of phase. A fair amount of asymmetry can be tolerated, but if they are so asymmetrical that a positive and negative transition of one channel can occur without an intervening transition from the other channel, then

you have trouble. You'll need to fiddle with the resistance values to set the IR emitter power and the receiver sensitivity.  
Temporarily wire in a couple linear taper 1 meg, 15-turn potentiometers in place of R2 and R3, and two 20K potentiometers in place of R1 and R4. The best way to do this is to clip the original resistors out of the circuit from the component side and solder some lengths of wire to the remaining pin stubs. Form twisted pairs from these wires for each resistor and solder each pair to the first pin and wiper of the corresponding potentiometer. As a starting point, adjust the resistance of each pot until they match the original values in

the circuit.  
With the servos running, tweak the pots of one channel at a time until you achieve two symmetrical waveforms with 90 degree phase difference between them. Once that's accomplished, disconnect power and measure the resistances of each pot and replace them with the nearest standard value fixed resistor.  
I know, this is not the easiest procedure. I'm working on a more elegant solution, but that will have to wait for another column because I am out of space this month. Anyway, next time I'll finish up with the encoder project with the software needed for the PIC to make sense of all these quadrature squarewaves. **NV**



Last month, we looked at buck and boost switching regulators — those that typically change +12 volts into +5 volts (buck converter), and +5 volts into +12 volts (boost converter). Neither are isolated from the source and have a limited convert up/down ratio. In this article, I'll show you how the industry deals with converting 110 VAC into 5 volts, 12 volts into 1000 volts, and +5 volts into -5 volts. As before, I'll provide design rules and typical applications.

In case you missed Part 1, or

need your memory refreshed, here are the switching topologies that are discussed in this series.

- **Buck:** Reduces a high DC voltage to a lower DC voltage.
- **Boost:** Increases a low DC voltage to a higher DC voltage.
- **Flyback:** Generates an output voltage that is lesser or greater than the input, including multiple output voltages.
- **Invert:** Generates a DC voltage which is opposite in polarity to the input voltage.

The buck and boost were reviewed in the May '99 issue. This month's article deals with the fly-

back and invert configurations.

## Flyback Converter

The granddaddy of all switching converters is the flyback circuit, better known to us ol'-timers as a flyback transformer. This circuit has roots that go back to the very beginning of modern electronics — back to the invention of the television, to be exact. At the heart of every TV set is a cathode ray tube (CRT) which requires a very high DC voltage — something on the order of 25 kV. Using a standard 60 Hz power transformer to generate this voltage is a bulky, heavy, and expensive proposition. To make the TV a viable consumer product, a cheaper, lighter-weight power supply was needed. Enter the flyback transformer.

The flyback converter is the most versatile of all the topologies, permitting step-up, step-down, and multiple voltage outputs. Unlike the buck and boost circuits, the flyback topology uses a real transformer, not a simple inductor. The configuration can also provide load isolation with mixed positive and negative voltage sources.

Yes, this is identical to the way a RadioShack transformer converts 110 VAC into 12 VAC and other voltages. The difference is the frequency of operation. Instead of driving the primary at 60 Hz, the switching flyback converter runs at 100 kHz and higher. The net benefits are:

- Smaller physical size
- Lighter weight
- Reduced ripple
- Tight voltage regulation
- Cheaper construction costs

The basic flyback converter is shown in Figure 1.

Essentially, this circuit works like the ignition coil under the hood of your car. When the switch

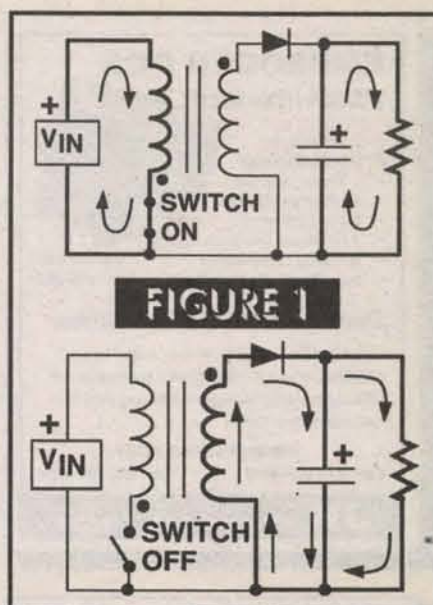


FIGURE 1

is closed, current flows through the primary of the transformer and builds up a magnetic field. When the switch is opened, the field collapses and transfers its energy to the secondary winding, inducing a voltage in that winding.

An important difference between an AC-line transformer — like a 12-volt RadioShack power transformer — and a flyback transformer is the phase relationship between the primary and secondary windings. In a power transformer, the output leads are interchangeable. In a flyback transformer, a proper phase relationship between the primary and secondary windings (as indicated by the dots in Figure 1) is imperative for proper operation.


Note that the dotted lead of the primary winding connects to the negative terminal of the source, while the undotted lead goes to the positive terminal. This phasing is just the opposite for the secondary winding, which returns its undotted lead to the negative terminal of the source.

When the switch is turned on, a voltage of opposite polarity appears across the secondary winding — a voltage that's blocked

# SWITCHING VOLTAGE REGULATOR BASICS — PART 2

by TJ Byers

## Weighing The Options



## EPROM+

A device programming system for design, repair and field service

- ◆ EXCEPTIONAL POWER FOR THE PRO
- ◆ EASY-TO-USE FOR THE NOVICE

Here's what you get: A rugged, portable programming unit including the power pack and printer port cable both of which store inside the case. A real printed user and technical manual which includes schematic diagrams for the programming unit plus diagrams for all technology family adapters\*. Comprehensive, easy-to-use software which is specifically designed to run under DOS, Windows 3.1, 95 and 98 on any speed machine. The software has features which let you READ, PROGRAM, COPY and COMPARE plus much more. You have full access to your system's disk including LOADING and SAVING chip data plus automatic processing of INTEL HEX, MOTOROLA S-RECORD and BINARY files. For detailed work the system software provides a full screen buffer editor including a comprehensive bit and byte tool kit with more than 20 functions.

Broad device support: Including FIRST GENERATION EPROMS (2708, TMS2716\*, 25XX etc.) SECOND GENERATION EPROMS (2716-27C080)(8 MEG), 40 and 42 PIN EPROMS\* (27C1024-27C160)(16 MEG) EEPROMS (2816-28C010) PLUS ER5901, FLASH EPROMS (28F, 29C, 29EE, 29F)(32 MEG), NVRAMS (12, 20, X2210/12) 8 PIN SERIAL EPROMS\* (24, 25, 85, 93, 95, 80011A) PLUS ER1400/MS8657\* BIPOLAR PROMS\* (74S/82S), SERIAL FPGA CONFIGURATORS (17CXXX) MICROS\* (874X, 875X, 87C5X, 87C75X, 89C) ATMEL MICROS\* (89S, 90S)(AVR) PIC MICROS\* 8, 18, 28, 40 PIN (12CXXX, 16C5X, 6X, 7X, 8X PLUS FLASH & 17C) MOTOROLA MICROS\* (68705P3/U3/R3, 68HC705C8/C9/J2/P9, 68HC711E9/D3)

Includes step-by-step tutorial plus explanation of EPROM fundamentals

1 YEAR WARRANTY - 30 DAY MONEY BACK GUARANTEE

\*REQUIRES SNAP-IN ADAPTER (ORDER FACTORY DIRECT OR BUILD YOURSELF)

\$289

\$5.00 SHIPPING - \$5.00 C.O.D.

VISA • MASTERCARD • AMEX

ANDROMEDA RESEARCH, P.O. BOX 222, MILFORD, OHIO 45150

(513) 831-9708 FAX (513) 831-7562

website - www.arlabs.com email - arlabs@worldnet.att.net MADE IN THE U.S.A.

## 5 Axis Robotic Arm Kit

\$195.00 Plus S&H




You can build this Robotic Arm! Impressive, fast, accurate and repeatable motion. Any computer capable of sending 2400 or 9600 baud serial data can control the arm, even a Basic Stamp! This arm makes a great foundation for AI and motion control experiments. Position the arm in an X, Y, Z, grid with a joystick or keyboard using the new RoboMotion for Windows. The kit includes all of the hardware and structural components, six quality Hitec HS-300 servos, pre-assembled SSC servo controller, DOS and Windows software, and an illustrated assembly manual.

We have many more cool robots, check out our web page or ask for our free catalog!

3 Axis Version \$155.00 • Mobile Version \$250.00 • Mobile Robots Book \$32.00

Lynxmotion, Inc.

104 Partridge Road

Pekin, IL 61554-1403 USA

http://www.lynxmotion.com

Tel: 309-382-1816

Fax: 309-382-1254

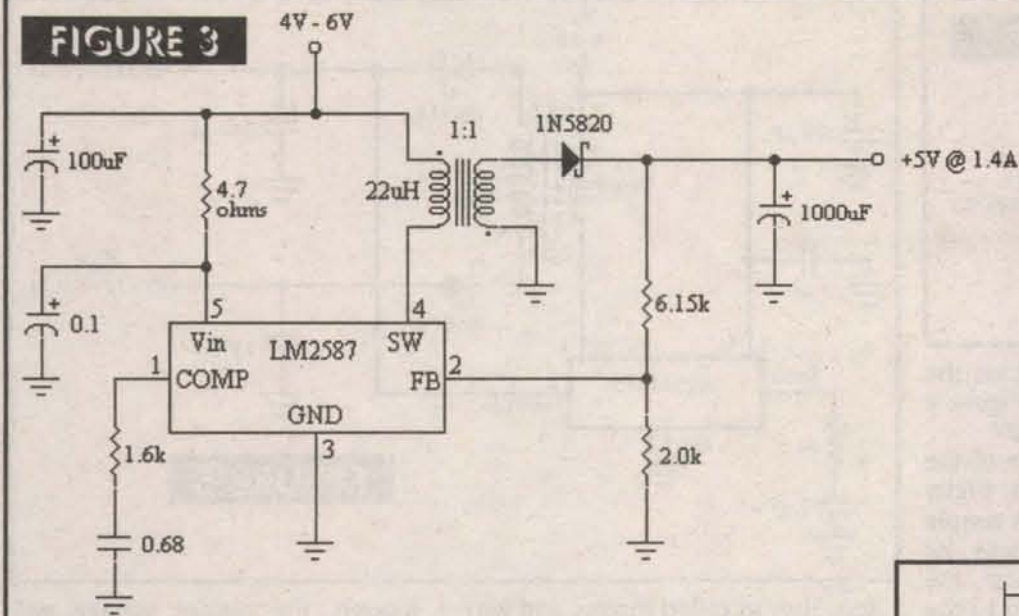
sales@lynxmotion.com

tech@lynxmotion.com



# Weighing The Options

**FIGURE 3**



from charging the capacitor by the diode. When the switch is opened, the primary field collapses and the dotted secondary lead swings positive, which now lets current pass through the diode into the capacitor and the load.

During the next cycle, the polarity reverses again, and the capacitor provides power to the load while the magnetic field builds up. And so it goes. Figure 2 shows the idealized waveforms for a flyback converter.

## Flyback Output Voltage

The secondary voltage is proportional to the number-of-turns between the primary and secondary windings. For a line-operated power transformer, the output voltage is equal to

$$V_{out} = V_{in} \times N(\text{turns ratio})$$

A RadioShack 12.6 volt transformer, for example, has a turns ratio of 10:1, whereas a 25.5 volt transformer has a 4.5:1 ratio. In both cases, there's a fixed relationship between output voltage, turns ratio, and the 110 VAC line.

Most switching flyback transformers, on the other hand, determine the output voltage by varying the amount of time current flows through the primary of the transformer. The ratio between the time the current is on and the time it's off is called the duty cycle, which is mathematically defined as:

$$d = \frac{t_{on}}{t_{on} + t_{off}}$$

In a feedback converter, the duty cycle and output voltage are determined by the following equations:

$$d = \frac{V_{out}}{N(V_{in}) + V_{out}} = V_{out} = N \times V_{in} \times d / (1-d)$$

where N equals the turns ratio between the primary and secondary windings.

Theoretically, the output voltage can be as large as desired — just keep increasing the turns ratio of the transformer. However, there are physical limitations that prevent the output voltage from increasing to infinity.

They include losses in the switching circuit, magnetic losses, and breakdown voltage of the insulators. Moreover, the flyback converter has the same limits of a power transformer; that is, you can't take out more power than you put in.

For example, if the input to the transformer is 5 volts and the switching current is 5 amps, the best you can hope for is 25 watts of power out (assuming no losses, of course). If the output voltage is 100 volts, the output current is just 250 mA — a far cry from the 5 amps you may have been expecting.

At some point, the ratio between higher voltage and lower current becomes unusable; infinite voltage out equals zero current out. Typically, PC-based flyback transformers have a turns ratio that ranges from 1:1 to 1:2.5.

## Typical Flyback Converter Application

Flyback circuits are the most forgiving because there's no critical magnetic component as in the previous buck and boost topologies. However, the closer you can match the flyback transformer to the switching frequency and output load, the more efficient it becomes. For this exercise, I've selected the LM2587.

As always, a bypass capacitor should be placed between the input pin and ground. It should consist of a low ESR aluminum electrolytic (100 uF) paralleled

Transformers	T1	T1	T1	T2	T3	T4
V <sub>in</sub>	4V-6V	4V-6V	8V-16V	4V-5V	18V-36V	18V-36V
V <sub>out1</sub>	3.3V	5V	12V	12V	12V	5V
I <sub>out1</sub> (Max)	1.5A	1.4A	1.2A	0.3A	1A	2.5A
N <sub>1</sub>	1	1	1	2.5	0.8	0.35
V <sub>out2</sub>				-12V	-12V	12V
I <sub>out2</sub> (Max)				0.3A	1A	0.5A
N <sub>2</sub>				2.5	0.8	0.8
V <sub>out3</sub>						-12V
I <sub>out3</sub> (Max)						0.5A
N <sub>3</sub>						0.8

**FIGURE 4**

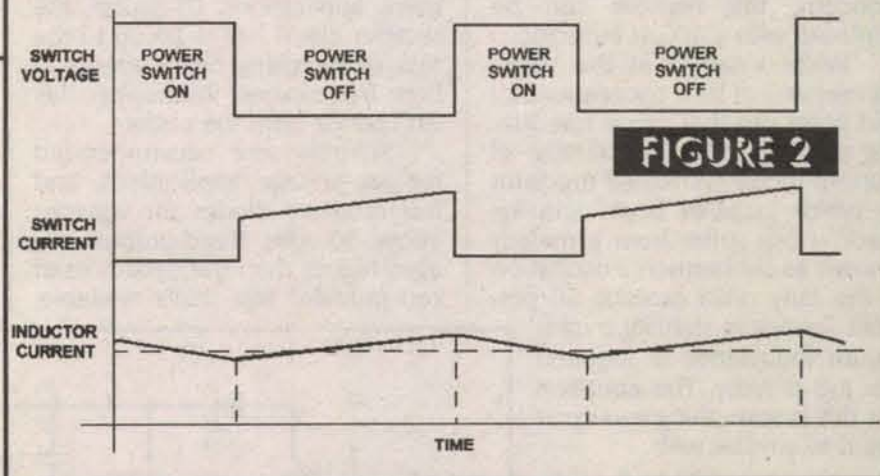
LM2587 Transformer Selection Table					
Transformer Type	Manufacturers' Part Numbers				
	Coilcraft (Note 15)	Coilcraft (Note 15) Surface Mount	Pulse (Note 16) Surface Mount	Renco (Note 17)	Schott (Note 18)
T1	Q4454-B	Q4435-B	PE-68411	RL-5530	67141450
T2	Q4337-B	Q4436-B	PE-68412	RL-5531	67140800
T3	Q4343-B	—	PE-68421	RL-5534	67140820
T4	Q4344-B	—	PE-68422	RL-5535	67140830

Note 15: Coilcraft (800-322-2645; <http://www.coilcraft.com>)

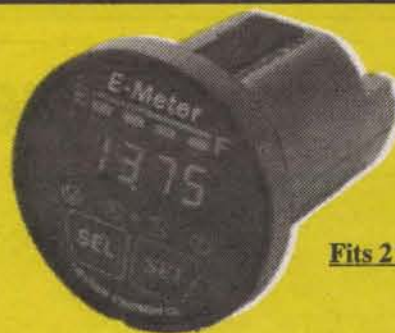
Note 16: Pulse Engineering (619-674-8100; <http://www.pulseeng.com>)

Note 17: Renco Electronics (800-645-5828; <http://www.rencousa.com>)

Note 18: Schott Corp. (612-475-1173; <http://www.schottcorp.com>)



# Y2K PLANNING? USING BATTERIES? GET AN *E-METER*<sup>TM</sup>



## From \$200

OEM's: Call for free applications assistance.

Fits 2" hole

Up to 1000 Amps  
@500 Volts!

Here's why *every* Y2K battery bank needs an *E-Meter* - the world's most popular DC energy monitor: The multi-color bar graph shows battery status at a glance. The bright digital display reports Volts, Amps, Amp-hours, Time Remaining, - even Kilowatt-hours. Reports historical information including battery Charge Efficiency, number of discharge cycles, deepest depth of discharge and average depth of discharge. The optional Low Battery contact can optimize your generator run times for charging and RS232 output is available for remote sites.

Don't be afraid of Y2K - be ready with an *E-Meter*!

## Cruising Equipment

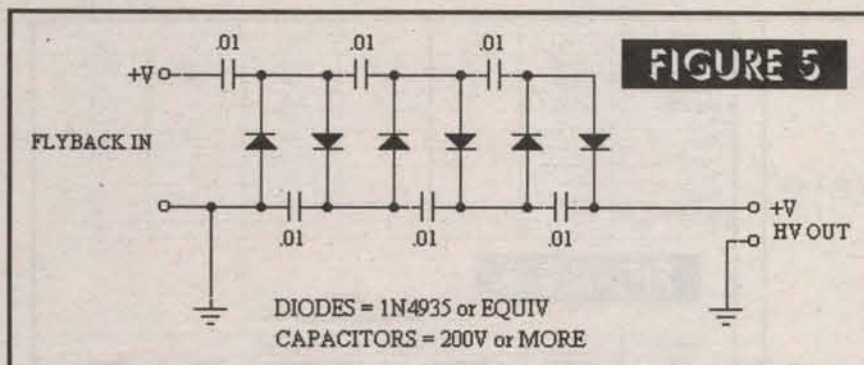
5245 Shilshole Ave. NW, Seattle, WA 98107

(206) 782-8100 Fax: (206) 782-4336

<http://www.cruisingequip.com>



# Weighing The Options



with a tantalum (1 uF). For serious applications, a small RC low-pass filter between the input pin and ground is recommended. Typically, it consists of a 4.7 ohm resistor and a 0.1 uF capacitor, as shown in Figure 3. If efficiency is a major concern, the resistor can be replaced with a 10 uH inductor.

While I said that the transformer was of little consequence, I did point out that some fine tuning was desirable. Specifically, all current-mode controlled regulator — which includes boost and flyback — can suffer from a malady known as subharmonic oscillation if the duty cycle exceeds 50 percent. To ensure stability, a minimum inductance is required for the primary. The equation for this is something you don't want to wrestle with.

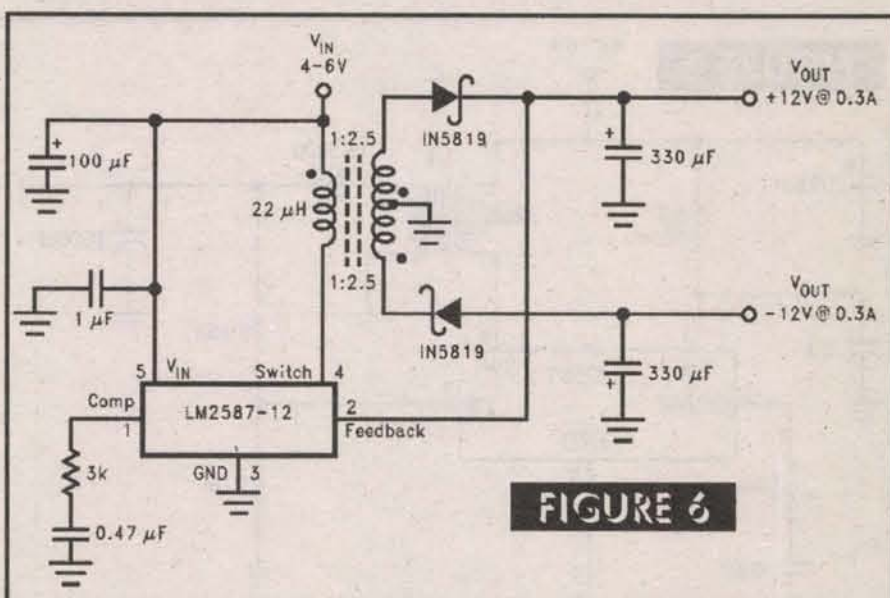
$$L = \frac{2.92(V_{in} \times (2d-1))}{1-d}$$

where L is in uH and d is the duty cycle. To ensure stability over the full range of operation, set  $V_{in}$  to  $V_{in}(\min)$  — the lowest expected input voltage — and d to d (max) (the maximum expected duty cycle). Personally I find this a lot of trouble, and so do a lot of other designers. That's why most switching regulator datasheets come

with a nomograph that does the calculations for you. See Figure 4 for the table for the LM2587.

On the secondary side of the transformer, you can do pretty much what pleases you. A simple diode and capacitor suffices for many applications. Of course, the rectifier diode has to be up to the task of switching high currents at high frequencies. Remember this isn't 60 Hz from the outlet.

Schottky are recommended for low-voltage applications, and fast recovery diodes for voltages above 50 volts. Need output voltages higher than the flyback itself can provide? Yep, that's available,



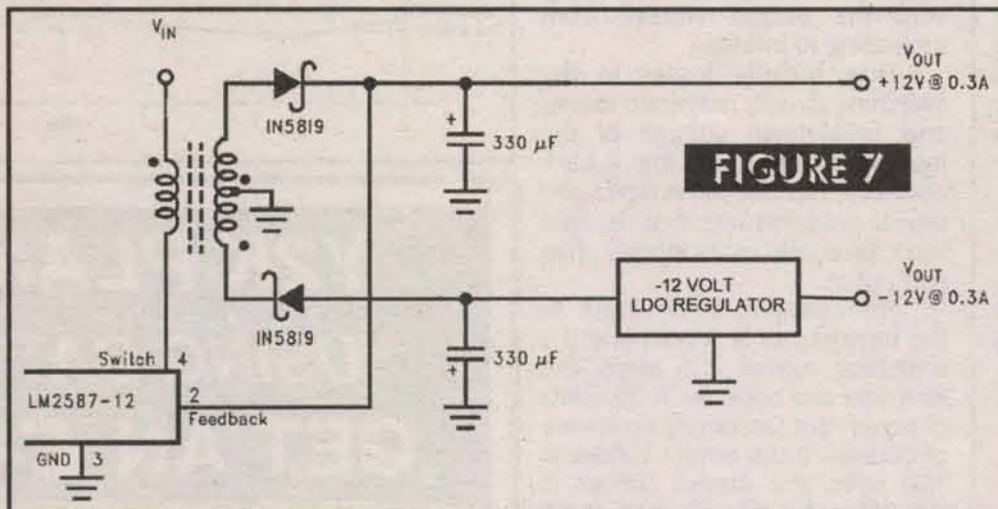
too. They're called triplers and you can find a bushel of them at your local TV/VCR repair shop, or you can build your own using the schematic in Figure 5.

As stated earlier, the output voltage is determined by the duty cycle of the current flowing through the primary of the transformer. Left to its own devices,

though, the output voltage will vary up or down, depending on the load. As the load increases, the output voltage decreases, and visa versa. To hold the output voltage constant, a technique called pulse-width modulation (PWM) is applied to the switcher.

Basically what PWM does is adjust the duty cycle of the input pulse to control the input power, and therefore the output voltage. When peak output is required, the width of the input pulse is very wide to pack a heavier charge into the transformer. When the load is light, the input pulses are narrow, like a picket fence.

To control the PWM, a part of the output voltage is fed back to the switching controller (pin 2 of the LM2587) using a resistor divider. What the controller does is adjust the width of the switching pulse so that the voltage on this pin is always 1.23 volts — a voltage that's typical of most adjustable switching regulators, including buck, boost, and flyback.



## Where To Buy

### SEMICONDUCTORS

#### Analog Devices

One Technology Way  
Norwood, MA 02062-9106  
(800) 262-5643  
<http://www.analog.com>

#### Linear Technology Corp.

1630 McCarthy Blvd.  
Milpitas, CA 95035  
(800) 454-6327  
<http://www.linear-tech.com>

#### Maxim Integrated Products

120 San Gabriel Dr.  
Sunnyvale, CA 94086  
(800) 835-8769  
<http://www.maxim-ic.com>

#### National Semiconductor

2900 Semiconductor Dr.  
P.O. Box 58090  
Santa Clara, CA 95052  
(408) 721-5000  
<http://www.national.com>

### INDUCTORS

#### Coilcraft, Inc.

1102 Silver Lake Rd.  
Cary, IL 60013  
(847) 639-6400  
<http://www.coilcraft.com>

#### Pulse Engineering

12220 World Trade Dr.  
San Diego, CA 92128  
(619) 674-8100  
<http://www.pulseeng.com>

#### Renco Electronics, Inc.

60 Jeffry Blvd., East  
Deer Park, NY 11729  
(800) 645-5828  
<http://www.rencousa.com>

#### Schott Corp.

1000 Parkers Lk. Rd.  
Wayzata, MN 55391  
(612) 475-1173  
<http://www.schottcorp.com>

Note 15: **Coilcraft** (800-322-2645;  
<http://www.coilcraft.com>)

Note 16: **Pulse Engineering** (619-  
674-8100; <http://www.pulseeng.com>)

Note 17: **Renco Electronics** (800-  
645-5828; <http://www.rencousa.com>)

Note 18: **Schott Corp.** (612-475-  
1173; <http://www.schottcorp.com>)

### CAPACITORS

#### AVX Corporation

3900 Electronics Dr.  
Raleigh, NC 27604  
(919) 878-6357  
<http://www.avxcorp.com>

#### Mallory North American Capacitor Company

7545 Rockville Rd.  
Indianapolis, IN 46214  
(317) 273-0090  
<http://www.nacc-mallory.com>

#### Murata Electronics North America, Inc.

2200 Lake Park Dr.  
Smyrna, GA 30080  
(770) 436-1300  
<http://www.murata.com>

#### Nichicon (America) Corp.

927 East State Pkwy.  
Schaumburg, IL 60173  
(847) 843-7500  
<http://www.nichicon-us.com>

#### Sanyo

(619) 661-6835

#### Sprague

(603) 224-1430

#### TOKIN America, Inc.

155 Nicholson Ln.  
San Jose, CA 95134  
(408) 432-8020  
<http://www.tokin.com>



# Weighing The Options

(In a fixed-voltage regulator, like the LM2587-5.0, the divider resistors are placed on the chip inside the IC.)

If the voltage falls below 1.23 volts, it means the output voltage is sagging, which prompts the controller to increase the width of the pulse. Rising voltages on the feedback pin force a reduction in pulse width. In a well-designed converter circuit, it's not unusual to find the output voltage held to within 20 mV of nominal. Here are typical resistance divider values for popular voltages.

OUTPUT VOLTAGE	R1	R2
3.3V	3.4k	2k
5.0V	6.15k	2k
12V 8.73k	1k	
15V 11.2k	1k	

## Generating Multiple Outputs

But we've only scratched the surface of the merits of flyback conversion. Not only can it provide a buck or a boost voltage, it can provide as many output voltages as you want using just one flyback transformer. Let's take a simple, dual-output power supply, like the kind needed for op amps (Figure 6).

Very often, op-amp circuits need a positive and negative power source. In fact, until just a few years ago, it was a requirement. Back in the days of old, these voltages were generated using a bipolar, tracking power supply, which were bulky and inefficient. While op-amp restrictions have relaxed since then, bipolar-powered circuits still have advantages over single-ended designs.

Our example starts off quite meekly as a simple flyback transformer voltage converter. In fact, the only change is in the secondary winding of the transformer, which is now center-tapped. Center-tapped transformers have been around for many years for different purposes.

Look at the power transformer options in any RadioShack catalog, and you'll see that nearly all sport a center tap. For our particular application, we're going to use that center-tap to generate a positive and a negative output voltage.

It's simple enough. We simply ground the center-tap so that the voltage is split in half, with 12 volts on the top and 12 volts on the bottom. Each half of the winding can now be treated as a separate transformer winding. On the top side, the output is run through a diode that has its anode lead connected to the transformer to

produce a positive voltage. On the bottom side, the output is run through the cathode lead of a rectifying diode to generate a negative voltage. Ground is common.

The rectified outputs are typical enough, but not the PWM feedback. By design, PWM can only sense one output voltage, not multiple outputs. In our example, the feedback pin is connected to the +12 volt output. That means that this line alone will be held within about 20 mV of 12 volts. The negative output, on the other hand, is unregulated. It depends on the pulse width of the positive line.

Let's say the +12V output demands more current. This prompts a larger duty cycle to satisfy the request. Let's also say that the current demands of the -12V output remains the same. Well, I guess you can guess the results. The negative output voltage goes up — by how much is determined by the change in the duty cycle.

Fortunately, there's a simple solution which has recently appeared on the scene. It's called a low-dropout voltage regulator, or LDO. It's inserted into the circuit like this (Figure 7). Need three outputs? Here's a block diagram of how it's done (Figure 8).

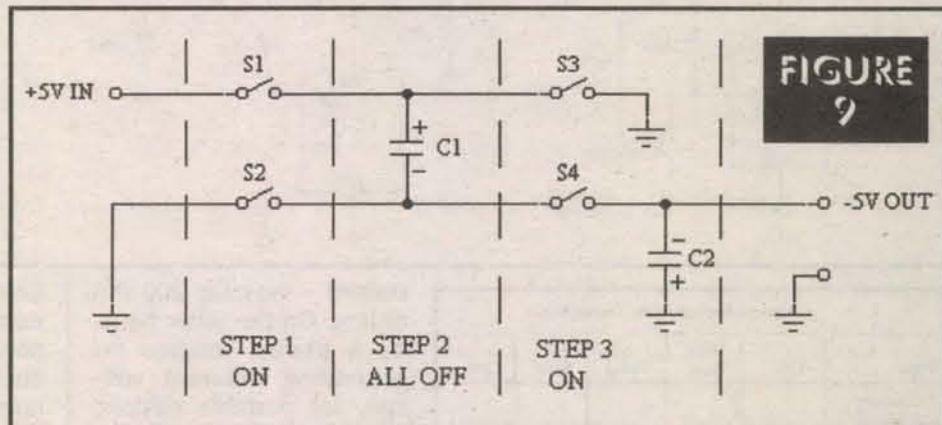
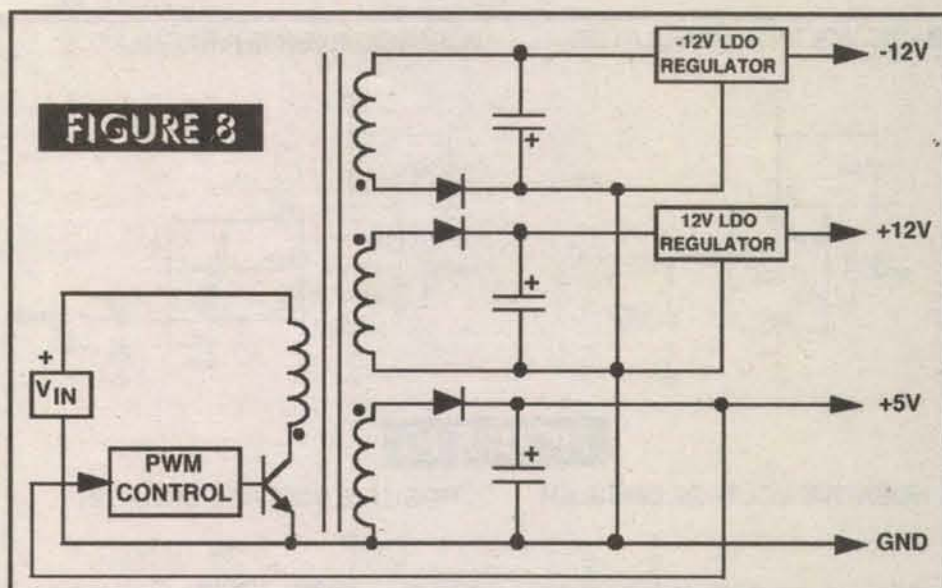
As before, only one output can be regulated. If you want regulation on the other outputs, you need additional regulators. Linear LDOs are preferred over introducing another switching regulator.

Don't forget, however, that you can't get more power out than you put in, which is why PC switching power supply specs often paint a tainted picture. Let's take a common 250-watt PC power supply, for example. Typically, it lists the outputs as:

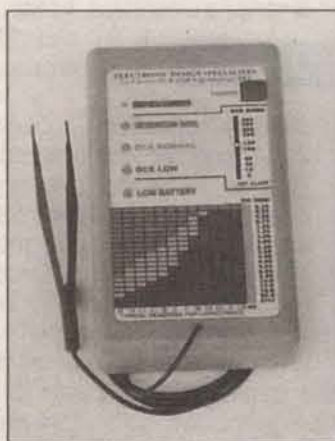
- +5V @ 30A
- +12V @ 10A
- -5V @ 1A
- -12V @ 0.5A

Added up, that comes to 281 watts, yet the power supply is only rated at 250 watts. How come? Well, it's because the outputs weren't meant to be working full-time all the time. They share.

For example, if the +5V load is drawing just 15 amps, the unused energy can be transferred to the +12V source to boost its output to about 16 amps, wiring and rectifier permitting. Just remember, altogether, they cannot exceed 250 watts.



## Don't be stupid.



Smart techs know that to be productive you need to find defective components quickly. Maybe that's why 37 TV stations, General Motors, Matsushita Industrial, Sears Service, Pioneer Electronics, Panasonic Authorized Service, and thousands more independent service technicians have chosen the *CapAnalyzer 88* over all of the other capacitor checkers. Check [www.eds-inc.com/88users.html](http://www.eds-inc.com/88users.html) for actual *CapAnalyzer* users' comments as they compare their *CapAnalyzer* to the "wizards" and "z-meters" they already own. They all prefer the *CapAnalyzer 88* because it

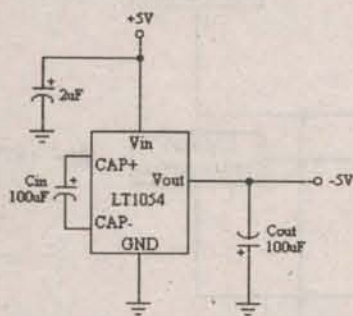
does what you expect it to do: check electrolytic capacitors, in-circuit, with 100% accuracy. Period. No unsoldering to check out-of-circuit, no mistaking a shorted or leaky cap as good, as other "ESR" meters do, no guessing about whether a value is good or bad. With our exclusive three-color chart right on the front panel, auto-discharge, multi-beep alert, and one-handed tweezer test probe, even your pet monkey could find defective caps in that problem TV, monitor or VCR in a few seconds. 55% of sales of *CapAnalyzers* are from recommendations by other *CapAnalyzer* owners, and 9% of sales are from previous customers buying a second unit. So get smart and buy one for yourself. It's only \$179. With our exclusive 60-day satisfaction-or-money-back guarantee, you risk nothing. Your only problem will be running out of work as you take care of all of those "dogs" that you've been sitting on. We're EDS. We make test equipment designed to make you money. Available at your distributor now. 561-487-6103

[www.eds-inc.com](http://www.eds-inc.com)



# Weighing The Options

BASIC VOLTAGE REGULATOR



VOLTAGE INVERTER/REGULATOR

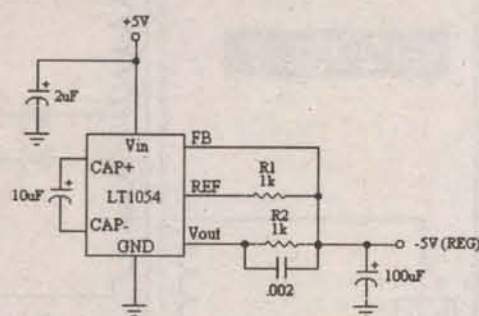
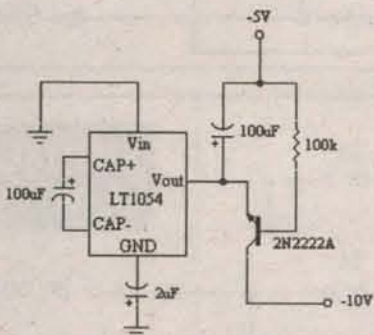


FIGURE 10

NEGATIVE VOLTAGE DOUBLER



POSITIVE VOLTAGE DOUBLER

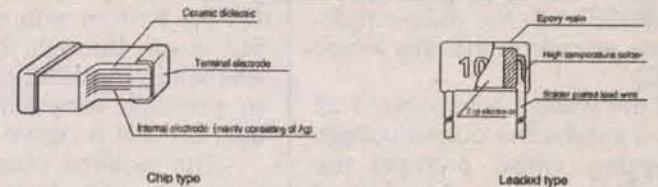
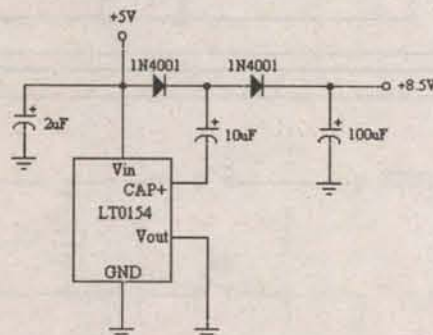
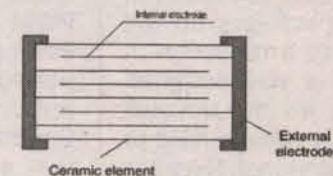


FIGURE 12



Cross-section of Multilayer Ceramic Capacitor Chip

power supplies for battery-operated equipment. Figure 10 shows a few examples of switched-capacitor applications taken from Linear Technology's LT1054 data sheet; just one of the devices we'll look at for this exercise.

As usual, a small bypass capacitor is recommended on the input pin, typically a 2 µF tantalum. For unregulated circuits, the value of Cin and

the noise will be reduced by the OS-CON capacitor.

Multilayer capacitors are also frequently used in switched-capacitor applications. Multilayer capacitors are high-dielectric capacitors made by sintering ceramic materials at a low temperature. Its advantages are high capacitance in a small size and layered construction that makes it especially well-suited for surface mount fabrication (Figure 12).

## Increasing Switched-Capacitor Output

In many cases, you can increase the output of a switched-capacitor converter by linking two or more devices. This is especially helpful when working with low-voltage, low-current converters, like the MAX829 from Maxim, which has a maximum rating of 5.5 volts in and 25 mA out. For higher output voltage, two devices can be cascaded, as shown in Figure 13. The unloaded output voltage is normally

$$-V_{out} = +V_{in} \times 2$$

but this value is reduced by the output resistance of the first device multiplied by the quiescent current of the second. When cascading more than two devices, the output resistance increases dramatically. As a rule, the larger the value of the charge-pump capacitor (Cp), the lower the output resistance — at least up to a point. Above a certain point, increasing the value of this capacitor has negligible effect on output resistance.

Paralleling switched-capacitor converters also reduces the output resistance — and increases the output current. The resultant output resistance is calculated using the formula

$$R_{out} = \frac{R_{out \text{ of a single device}}}{\text{number of devices}}$$

Each device must have its own pump capacitor (Cp), but only one output capacitor (Cout) is needed for the parallel devices (Figure 13). The value of this

current — typically 200 mA or less. On the other hand, it's a perfect solution for generating different voltages for portable devices, like handheld instruments and cell phones.

How an inverting switched-capacitor circuit works is a lesson in design simplicity (Figure 9). There are three steps to the inverter's operation. In Step

FIGURE 11

1, S1 and S2 are closed, which charges capacitor C1. Step 2, S1 and S2 are opened. This is done to prevent overlapping as switches S3 and S4 are closed, and the charge of C1 is transferred to C2. Watch the polarity as the transfer takes place.

What used to be ground is now the negative output and the positive is grounded. S3 and S4 are then opened and the cycle repeats. Generally, the output voltage is not regulated, just simply inverted.

By arranging the switches and capacitors in other configurations, voltages can be doubled in either polarity. Several switched-capacitor converters provide voltage regulation by using a PWM to control the switches time on and time off — just like their inductive counterparts.

## Typical Switched-Capacitor Applications

Switched-capacitor converters are typically simpler than their inductive counterparts. Very often they're used to create bipolar

Cout should be equal. While the exact values of Cin and Cout are noncritical, the quality of the capacitor is; they must be low ESR capacitors to reduce ripple.

Since ESR is a function of the operating frequency, you need to make sure the capacitor's value is rated at the circuit's operating frequency. In general, the capacitor's ESR is inversely proportional to its physical size, so capacitors with larger capacitance values and higher operating voltage tend to reduce ESR.

However, not all manufacturers guarantee capacitor ESR in the range required by the circuit, which is why many vendors publish charts listing recommended capacitor types and manufacturers. See Figure 11 for a chart from Analog Devices' ADP3605 data sheet.

What's an OS-CON capacitor, you ask? I, too, was confused until I looked it up. Invented by Sanyo in 1982, the OS-CON is an aluminum electrolytic type capacitor with an organic semiconductive electrolyte. Some of its features are:

- Very low ESR
- Totally temperature independent
- Wide frequency range
- High ripple current capability
- Long life

Just the prescription for a switched-capacitor converter. And because of these properties, a much smaller capacitance value can be used as compared to a normal aluminum electrolytic capacitor. Moreover, bypass capacitors can often be eliminated in less demanding applications because

Alternative Capacitor Technologies

Type	Life	High Freq	Temp	Size	Cost
Aluminum Electrolytic Capacitor	Fair	Fair	Fair	Small	Low
Multilayer Ceramic Capacitor	Long	Good	Poor	Fair <sup>1</sup>	High
Solid Tantalum Capacitor	Above Avg	Avg	Avg	Avg	Avg
OS-CON Capacitor	Above Avg	Good	Good	Good	Avg

NOTE  
<sup>1</sup>Refer to capacitor manufacturer's data sheet for operation below 0°C.

Recommended Capacitor Manufacturers

Manufacturer	Capacitor	Capacitor Type
Sprague	672D, 673D, 674D, 678D	Aluminum Electrolytic
Sprague	675D, 173D, 199D	Tantalum
Nichicon	PF and PL	Aluminum Electrolytic
Mallory	TDC and TDL	Tantalum
TOKIN	MLCC	Multilayer Ceramic
Murata	GRM	Multilayer Ceramic

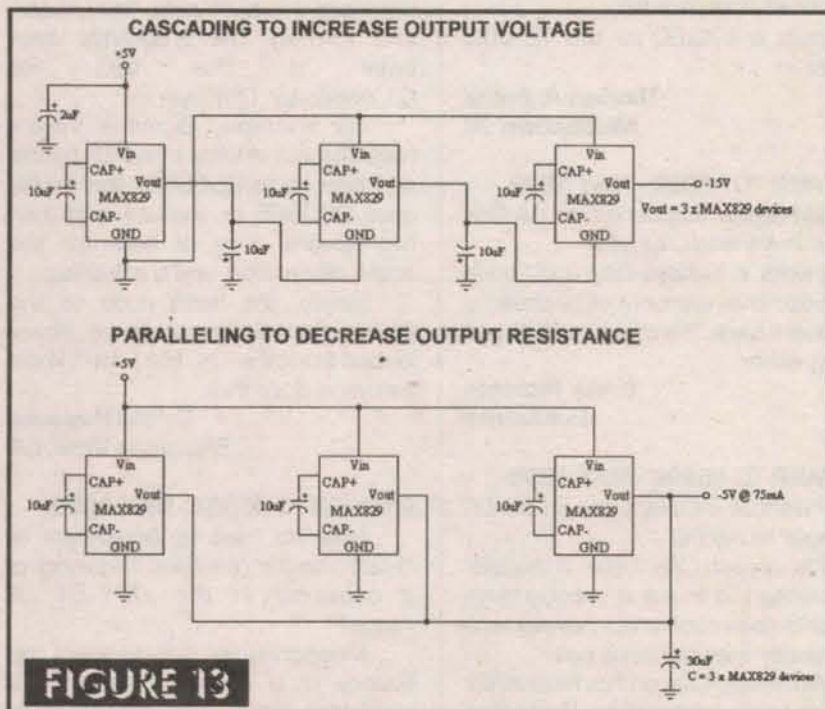
## Inverting Regulator

Sometimes called a buck-boost converter, the inverting regulator takes a DC voltage and changes it to a voltage of opposite polarity. Furthermore, the voltage can be higher or lower than the input. More often than not, though, the output is a mirror image of the input.

Unlike the converters described above — all of which rely on magnetics — inverting regulators normally use switched capacitors to accomplish their goal. The correct term is called charge-pump, but switched-capacitor is the most popular term used. While the weight and expense of magnetics is gone, the tradeoff is lower output



# Weighing The Options



capacitor is directly proportional to the number of devices paralleled. For two chips, it's twice the original capacitance, three times for three chips, and so forth.

## Just Touchin' The Basics

There's a lot more that I can say about switching converters, but space doesn't permit. You can

obtain more information on switching regulators from the data sheets cited from <http://www.questlink.com> and the answers you'll find in this month's Electronics Q & A column. Want even more? Download the f5.pdf file, a whitesheet on switching regulator technology written by National Semiconductor, that's posted on our web site (<http://www.nutsvolts.com>). NV

## Serial in, graphics out. Almost too easy.

These serial displays take RS-232 at 2400 or 9600 baud and produce stunning text and graphics on a supertwist LCD screen. See our complete line at [www.seetron.com](http://www.seetron.com). All models are in stock for immediate delivery.

### G12032 120x32-pixel LCD \$99.00

- Same size as 2x16 text LCD
- Editable font(s) in 4 sizes
- Up to 6 screens in EEPROM
- Easy terminal protocol



(3.2 x 1.4 in.)



(3.7 x 2.8 in.)

### G12864 128x64-pixel LCD \$199.00

- Large, sharp LCD
- Editable font(s)
- Up to 14 screens in flash
- Separate text, graphics layers
- DB9 connector built in
- AC adapter jack built in
- Easy terminal protocol

[www.seetron.com](http://www.seetron.com)

Scott Edwards Electronics, Inc. • ph 520-459-4802 • fx 520-459-0623 • [nrv@seetron.com](mailto:nrv@seetron.com)

Write in 49 on Reader Service Card.

# AST GLOBAL ELECTRONICS

24529 STATE HWY. 408, CAMBRIDGE SPRINGS, PA 16403  
VOICE 814-398-8080 • 1-888-216-7159 • FAX 814-398-1176

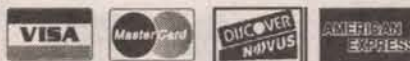
VIEW COMPLETE LISTING AT:  
<http://www.astglobal.com>

IF WE DON'T CARRY IT ... WE'LL FIND IT  
QUICKLY ... AT REASONABLE PRICES.

B&K 3020, Sweep/Function Generator, 2MHz (Sine, Square, Triangle).....	\$175	HP 8443A, Tracking Generator, 1KHz-110MHz.....	\$275
EIP 545, Microwave Counter 18GHz.....	\$500	HP 8445B, Auto Preset, 1.8-18GHz.....	\$350
ESI DP1311, Variable Resistor, 100K max 1K/Step.....	\$75	HP 8557A/180TR, Spectrum Analyzer, .01-350MHz.....	\$850
Fluke 332B, DC Voltage Standard.....	\$350	HP 8601A, Sweep Generator, 1-110MHz.....	\$400
Fluke 382A, Voltage/Current Calibrator.....	\$400	HP 8614A, Signal Generator, 800-2400MHz, AM/FM Leveled.....	\$300
Fluke 540B, Transfer Standard w/A54-2 Voltage Plug-in.....	\$475	HP 8616A, Signal Generator UHF, 1.8-4.5GHz, +10-120dB, AM/FM.....	\$300
Fluke 845AB, Null Detector/Micro Voltmeter 1uV-1000VDC.....	\$375	HP 8620C, Frame w/8222B Sweeper .01-2.4GHz.....	\$1,150
Fluke 893A, AC/DC Differential Voltmeter 0 to 1100 Volts, AC/DC, .01%DC, .05%AC, 1uV Resolution.....	\$75	HP 8624D, RF Plug-in, 5.9-9.0GHz.....	\$225
Fluke 3330B, Constant Current/Voltage Calibrator.....	\$325	HP 8640B, Signal Generator, .5-1050MHz, Opt. 002/001 or 003.....	\$1,800
Fluke 5100B, Multifunction Calibrator, Opt. 03/05.....	\$2,800	HP 8640B, Signal Generator, .5-512MHz, Opt. 001 or 003.....	\$700
Fluke 5100B, Multifunction Calibrator.....	\$2,700	HP 8660C, Frequency Synthesizer w/86603A/86601A/86632B.....	\$2,500
Fluke 5200A, Programmable AC Calibrator.....	\$1,000	HP 8743A, Reflection Test Set, 2-12.4GHz.....	\$200
Fluke 5215A, Precision Power Amp.....	\$800	HP 8901A, Modulation Analyzer.....	\$800
Fluke 6070A, Synthesized RF Signal Generator 200KHz-520MHz.....	\$1,400	HP 59303A, D/A Converter.....	\$125
Fluke 8000A, DMM 3-1/2 Digit.....	\$50	HP 59501A, HP-IB Isolated D/A Converter.....	\$100
Fluke 8050A, DMM 4-1/2 Digit w/Battery Pack.....	\$145	Keppco ATE15-50M, Power Supply, 0-15V @ 50A (metered).....	\$500
Fluke 8520A, DMM 4-1/2 Digit.....	\$275	Keppco ATE55-5M, Power Supply, 55V @ 5A.....	\$350
Fluke 8520A, DMM 4-1/2 Digit w/Battery Pack.....	\$100	Keppco BVP100-4M, Bi-Polar Power Supply, 0-100V @ 4A (metered).....	\$375
Fluke 8800A, DMM 5-1/2 Digit.....	\$125	Keppco JCE 36-15MVP, Power Supply, 0-36 @ 15A (metered).....	\$275
Fluke 9010A, Micro System Troubleshooter.....	\$375	Keppco JCE 36-3MVP, Power Supply, 0-36 @ 3A (metered).....	\$175
Gigatronics 6061A, Synthesized Signal Generator 10KHz-1050MHz.....	\$2200	Krohn-Hite 3202R, Dual Channel Tunable Filter, 20Hz-2MHz, High Pass, Low Pass Band Reject.....	\$200
HP 141T, Spectrum Analyzer Mainframe.....	\$475	PG506A, Calibration Generator Plug-in.....	\$500
HP 141T, Spectrum Analyzer w/8552B/8553B, 1KHz-110MHz.....	\$1,000	Polard SPNH, Signal Generator, 20Hz-20KHz.....	\$275
HP 141T, Spectrum Analyzer w/8552B/8553B, 1KHz-110MHz.....	\$1,200	Polard SPNL, Signal Generator, 1Hz-600KHz.....	\$200
HP 141T, Spectrum Analyzer w/8552B/8558A, 20Hz-300KHz.....	\$1,100	Racal Dana 9303, True RMS RF Level Meter.....	\$200

## INVENTORY REDUCTION SALE PRICES SLASHED UP TO 50%

HP 141T, Spectrum Analyzer w/8552B/8554B, 1KHz-1.2GHz.....	\$1,700	Tek 7870, Plug-in (200MHz), Time Base.....	\$50
HP 141T, Spectrum Analyzer w/8552B/8555A, 10MHz-19GHz.....	\$1,900	Tek 7880, Plug-in (400MHz), Delayed Time Base.....	\$100
HP 180TR, Scope Mainframe.....	\$250	Tek 7892A, Plug-in (500MHz), Dual Time Base.....	\$125
HP 204B, Oscillator, 5Hz-1.2MHz, 5VRMS.....	\$100	Tek 7D11, Plug-in Digital Delay.....	\$125
HP 204C, Oscillator, 5Hz-1.2MHz, 5VRMS.....	\$125	Tek 7D13, Plug-in DMM 3-1/2 Digit.....	\$100
HP 214A, Pulse Generator, 20V-100V.....	\$200	Tek 7D15, Plug-in Counter/Timer, DC-225MHz.....	\$175
HP 334A, Distortion Analyzer.....	\$275	Tek 7L13, Spectrum Analyzer, 100KHz-1.8GHz.....	\$1,200
HP 339A, Distortion Analyzer w/Low Distortion Oscillator.....	\$950	Tek 7S11, Plug-in Sampling Unit.....	\$125
HP 350A, Attenuator.....	\$75	Tek 134, Current Probe Amp.....	\$75
HP 400EL, AC Voltmeter, 10Hz-10MHz.....	\$150	Tek 453, Scope (60MHz), Dual Trace.....	\$175
HP 400FL, RMS Voltmeter, 20Hz-4MHz, 100uV-300V.....	\$175	Tek 465, Scope (100MHz), Dual Trace.....	\$425
HP 415E, SWR Meter.....	\$100	Tek 465B, Scope (100MHz), Dual Trace.....	\$475
HP 4276A, LCZ Meter.....	\$1,700	Tek 466, Scope (100MHz storage), Dual Trace.....	\$575
HP 432A, Power Meter w/Cable/8478, .01-18GHz Sensor.....	\$350	Tek 475, Scope (200MHz), Dual Trace.....	\$475
HP 432A, Power Meter w/Cable/Sensor.....	\$150	Tek 475A, Scope (250MHz), Dual Trace.....	\$625
HP 435A, Power Meter w/Sensor/Cable.....	\$100	Tek 485, Scope (350MHz), Dual Trace.....	\$700
HP 436A, Power Meter w/Cable/Sensor.....	\$475	Tek 482, Opt. 2 Spectrum Analyzer 50KHz-21GHz.....	\$3,400
HP 651B, Test Oscillator, 10Hz-10MHz.....	\$125	Tek 520A, NTSC Vectorscope.....	\$400
HP 652B, Test Oscillator, 10Hz-10MHz.....	\$125	Tek 2213, Scope (60MHz), Dual Trace.....	\$375
HP 654A, Oscillator, 10Hz-10MHz, 90dB Attenuator.....	\$195	Tek 2215, Scope (60MHz) Dual Trace.....	\$450
HP 16300, Logic Analyzer w/pods.....	\$550	Tek 2235, Scope (100MHz) Dual Trace.....	\$650
HP 3312A, Function Generator, 1Hz-13MHz.....	\$490	Tek 2247A, Scope (100MHz) Dual Trace w/Counter/Timer/Volmeter.....	\$1,550
HP 3325A, Programmable Frequency Synthesizer 1Hz-32MHz.....	\$950	Tek 2336, Scope (100MHz) Dual Trace.....	SPECIAL \$525
HP 3330B, Automatic Synthesizer, 20Hz-13MHz.....	\$295	Tek 2445, Scope (150MHz), 4-Channel Cursor Readout.....	\$1,100
HP 3400A, True RMS Voltmeter, 10Hz-10MHz, 1mV-300V.....	\$125	Tek 2445A, Scope (150MHz), 4-Channel Cursor Readout.....	\$1,400
HP 3403C, True RMS Meter, AC/DC/40dB 100MHz.....	\$275	Tek 2465, Scope (300MHz), 4-Channel Cursor Readout.....	\$1,600
HP 3406A, RF Voltmeter, 50uV-3V, 1.2GHz.....	\$200	Tek 7104, Scope (1GHz), Dual Trace.....	\$1,200
HP 3455A, DMM 5-1/2 Digit.....	\$250	Tek 7603, Scope Mainframe (100MHz).....	\$150
HP 3456A, DMM 6-1/2 Digit.....	\$525	Tek 7704A, Scope Mainframe (250MHz).....	\$150
HP 3466A, DMM 4-1/2 Digit, AC/Battery, 5 Function.....	\$175	Tek 7904, Scope Mainframe (500MHz).....	\$225
HP 3478A, DMM 5-1/2 Digit.....	\$525	Wavetek 145, Pulse/Function Generator, .0001-20MHz.....	\$300
HP 3551A, Portable Transmission Test Set.....	\$550	Wavetek 185, Lin Log Sweep Generator, .0001Hz-5MHz.....	\$300
HP 3575A, Digital Phase Gain Meter 1Hz-13MHz.....	\$500	Wavetek 288, Synthesized Function Generator, 20Hz-20MHz (unused).....	\$800
HP 3580A, Spectrum Analyzer, 5Hz-50KHz, LED Readout.....	\$950	Wavetek FG3B, Sweep/Function Generator 2Hz-100KHz (unused).....	\$200
HP 3580A, Spectrum Analyzer, 5Hz-500KHz, Mechanical.....	\$500		
HP 3581A, Wave Analyzer, 15Hz-50KHz.....	\$300		
HP 3770A, Amplitude/Delay Distortion Analyzer.....	\$300		
HP 3779B, Primary MPX Analyzer.....	\$500		
HP 3781B, Pattern Generator.....	\$250		
HP 5316A, Counter, 100MHz, HP-IB.....	\$350		
HP 5328A, Counter, 100MHz w/DVM Opt. 021.....	\$200		
HP 5334A, Counter, 100MHz, Opt. 010 Over.....	\$500		
HP 5340A, Counter, 18GHz (noise).....	\$600		
HP 5345A, Counter, 500MHz.....	\$450		
HP 5345A, Counter, 500MHz, HP-IB.....	\$650		
HP 59307A, VHF Switch.....	\$100		
HP 6112A, Power Supply, 40V @ .5A (metered).....	\$150		
HP 6202B, Power Supply, 40V @ .75A (metered).....	\$150		
HP 6203B, Power Supply, 7.5V @ 3A (metered).....	\$150		
HP 6205B, Power Supply (dual), 0-40V @ .3A, 0-20V @ .8A (metered).....	\$175		
HP 6206B, Power Supply, 0-60V @ 1A (metered).....	\$200		
HP 6260B, Power Supply, 10V @ 100A (metered).....	\$300		
HP 6265B, Power Supply, 40V @ 3A (metered).....	\$200		
HP 6266A, Power Supply, 40V @ 6A (metered).....	\$200		
HP 6289A, Power Supply, 0-40V @ 1.5A (metered).....	\$175		
HP 6294A, Power Supply, 0-60V @ 1A (metered).....	\$200		
HP 8011A, Pulse Generator, 1Hz-20MHz.....	\$175		
HP 8013B, Pulse Generator, 1Hz-50MHz.....	\$275		
HP 8015A, Pulse Generator, 1Hz-50MHz 30V.....	\$400		
HP 8091A, Rate Generator (1GHz) w/8092A Delay Generator (1GHz) w/8093A Output Amp w/15401A & 15400A.....	\$1,000		
HP 8165A, Programmable Sig Source, 1mHz-50MHz.....	\$1,450		
HP 8180A, Data Generator.....	\$350		
HP 8350B, Sweep Oscillator Mainframe.....	\$1,550		
HP 8410B, Network Analyzer Mainframe.....	\$200		
HP 8411A, Frequency Converter, 11-18GHz.....	\$250		
HP 8411A/D18, Frequency Converter, 11-18GHz.....	\$375		
HP 8414A, Polar Display.....	\$225		



- 60-DAY WARRANTY
- 10-DAY RIGHT OF RETURN
- SATISFACTION GUARANTEED

Write in 48 on Reader Service Card.



# ELECTRONIC TEST EQUIPMENT BOUGHT & SOLD

90 DAY WARRANTY PARTS & LABOR • 10 DAY RIGHT OF RETURN, OPEN ACCOUNTS

Altech 360D11, Frequency Syn. .01-2GHz	\$800	HP 86290A, RF Plug-In, 2-18GHz	\$1,200
Altech 7615, Noise Source, 28VDC, .01-1.5GHz	\$250	HP 86290B, RF Plug-In, 2-18GHz	\$1,400
Altech Type 32, Precision Attenuator, 0-100dB	\$300	HP 8643A, Synthesized Frequency Generator	\$8,000
Argosystems AS210, Frequency Calibration System	\$2,000	HP 8656B, Signal Generator, 1-990MHz, AM/FM	\$2,000
Austron 2100R, Loran-C Frequency Monitor	\$500	HP 8660C, Freq Syn w/86603A & 86635A, 2.6GHz	\$2,500
Bird 4381, RF Power Analyzer, Opt. 832	\$200	HP 86601A, RF Plug-In, 110MHz	\$300
Boonton 26A, Millivoltmeter Calibrator	\$100	HP 86602A, RF Plug-In, 1300MHz	\$500
Boonton 82AD, Modulation Meter	\$450	HP 86603A, RF Plug-In, 2600MHz	\$1,000
Boonton 92BD, Digital RF Millivolt Meter	\$250	HP 8672A/01, Signal Generator, 2-18GHz	\$5,000
Boonton 102B, Signal Generator, 45-520MHz	\$500	HP 8697A, RF Plug-In, 26.5-40GHz	\$250
Boonton 518-A4, Q Standard	\$100	HP 8743A, Reflection Transmission Test Set	\$200
Boonton 2500, DC Range Calibrator	\$250	HP 8743A/018, Reflection Transmission Test Set, 18GHz	\$300
Boonton 4200/4G, Power Meter Sensor, .01-26.5GHz	\$200	HP 8750A, Storage Normalizer, Includes Cable	\$250
Boonton 4220/51013, Power Meter with Sensor	\$600	HP 8753A, Network Analyzer, Opt. 010	\$5,000
Boonton 4300, Power Meter, 2 Channel	\$1,200	HP 8753B, Network Analyzer, Opt. 002,006,010	\$10,000
Brue & Kjaer 1612, Bandpass Filter	\$250	HP 8753C, Network Analyzer	\$12,000
Calif. Inst. 101T, AC Power Source	\$400	HP 8756A, Scalar Network Analyzer	\$1,500
Eaton 380K11, Frequency Synthesizer, 1-2000MHz	\$2,000	HP 8901A, Modulation Analyzer	\$1,000
EIP 371, Source Locking Microwave Counter, 18GHz	\$1,000	HP 8901B, Modulation Analyzer, Opt. 001	\$1,500
EIP 545A, Microwave Counter, Opt. 02,05,08	\$1,000	HP 8903B, Audio Analyzer, Opt. 001	\$2,500
EIP 578, Source Locking Microwave Counter, 26.5GHz	\$2,200	HP 8920D, Dual-Mode Cellular Mobile Test System	\$10,000
EIP 931, Microwave Source, .01-18.6GHz, Opt. 9320	\$6,000	Opt. 002,008,014	\$10,000
ESI 296, Auto LCR Meter	\$800	HP 8970A, Noise Figure Meter	\$4,000
Fuke 515A, Portable Calibrator	\$800	HP E3617A, DC Power Supply, 0-40V, 1A	\$250
Fuke 540B, Thermal Transfer Standard	\$500	HP K486A, Power Sensor, 18-26.5GHz	\$250
Fuke 5450A, Programmable Resistance Calibrator	\$1,000	HP P486A, Power Sensor, 12.4-18GHz	\$100
Fuke 6010A, Frequency Synthesizer, 10Hz-11MHz	\$300	HP K486A, Power Sensor, 8.2-12.4GHz	\$100
Fuke 6080A/AN Frequency Syn., 5-1024MHz	\$4,000	Hughes 8010H, TWT Amplifier, 3-8GHz	\$1,000
Fuke 8520A, Digital Multimeter	\$250	Hunttron HTR 1005B, Tracker Component Tester	\$200
Fuke 8922A, True RMS Voltmeter	\$250	Keithley 192, Programmable DMM, 6.5 Digits, HP/IB	\$600
Fuke A55, Thermal Converter	\$200	Keithley 195A, Digital Multimeter	\$300
FTS 1150/001, Frequency Standard	\$400	Keithley 614, Electrometer	\$700
General Microwave 478A, Peak Power Meter	\$700	Krohn-Hite 3202, Filter, LP, HP, BP, Unused	\$350
General Radio 1557, Vibration Calibrator	\$400	Leeds & North 1091, Capacitor Decade, .001uF-1uF	\$150
Gigatronics 600/6-12, Frequency Synthesizer	\$1,000	Micronetics NSI-52640W, Noise Source, 26.5-40GHz	\$350
Gigatronics 600/10-18, Frequency Synthesizer	\$1,500	Narda 5082, High Directivity Bridge, 2-18GHz	\$300
Gigatronics 910, Frequency Synthesizer, .05-26GHz, Opt. 03/06	\$8,000	Narda 5292 Directional Coupler, 1-18GHz	\$200
Guidline 9154C, Transvoltage Standard Cell	\$300	Racal Dana 1515, Delay Pulse Generator	\$500
Guidline 9577, Precision DMM, 7.5 Digits	\$300	Racal Dana 1992, Frequency Counter, High Stab.	\$500
Hitachi V-212, Scope, 20MHz, Dual Trace	\$200	Racal Dana 9082P, Signal Gen. 1.5-520MHz	\$400
HP 11590A, Bias Resonance	\$250	Racal Dana 9303, True RMS RF Level Meter	\$400
HP 11604A, Universal Extension	\$100	Simco A300, Aerostat Anti-static	\$100
HP 11605A, Flexible Arm	\$100	Tek 134, Probe Amplifier for P6021 & P6022	\$100
HP 11638A, Calibration Kit, Type N	\$600	Tek 1470, NTSC Color Sync & Test Sig. Generator	\$500
HP 11665B, Modulator	\$250	Tek 1502, TDR, Opt. 4, Chart Recorder	\$1,000
HP 11713A, Attenuator Switch Driver	\$400	Tek 1502C, TDR	\$3,500
HP 11869A, Adaptor for Plug-In 8350A/B	\$350	Tek 1503/01/05, TDR, Scale in Meters	\$1,000
HP 11970A, Harmonic Mixer, 26.5-40GHz	\$800	Tek 1503B, TDR, Opt. 06	\$3,000
HP 11970K, Harmonic Mixer, 18-26.5GHz	\$800	Tek 176, Pulsed High Current Fixture for 576	\$500
HP 11970Q, Harmonic Mixer, 33-50GHz	\$800	Tek 178, Linear IC Test Fixture, For 577	\$150
HP 1600A, Logic Analyzer w/ports	\$400	Tek 1730D, Digital Waveform Monitor	\$500
HP 1630D, Logic Analyzer w/ports	\$500	Tek 2246, Oscilloscope, 4-Channel, 100MHz, Cursors	\$1,200
HP 16510B, Logic Analyzer Card, 16500A System	\$500	Tek 2432, Scope, Digital, 300MHz, 4 Channel, HP/IB	\$2,000
HP 16530A/16531A, Digital Scope Card, 16500A System	\$500	Tek 2445A, Scope, 150MHz, 4 Channel	\$1,200
HP 214B, Pulse Generator	\$1,000	Tek 2445B, Scope, 150MHz, 4 Trace, HP/IB	\$1,500
HP 33102A, Microwave Switch, 100MHz-18GHz	\$100	Tek 2465, Scope, 300MHz, 4 Channel	\$1,500
HP 3314A, Function Generator, Opt. 001	\$1,500	Tek 2465A, Scope, 350MHz, 4 Channel	\$2,000
HP 3325A, Function Generator	\$1,000	Tek 305DMM, Scope, 10MHz, Dual Trace, DMM, battery	\$500
HP 3325A/01/02, Function Gen., Opt. 01/02	\$1,500	Tek 318, Logic Analyzer w/ports	\$500
HP 33222H, Programmable Attenuator, DC-18GHz	\$250	Tek 464, Scope, 100MHz Dual Trace, Storage	\$400
HP 3335A, Frequency Synthesizer, 200Hz-81MHz	\$4,000	Tek 465, Scope, 100MHz Dual Trace	\$400
HP 3400A, RMS Voltmeter, 10Hz-10MHz	\$200	Tek 492, Spectrum Analyzer, Opt. 01/02	\$4,500
HP 3403C, True RMS Voltmeter	\$200	Tek 492, Spectrum Analyzer, Opt. 01/02/03	\$5,000
HP 3455A, Digital Multimeter	\$300	Tek 492/02, Spectrum Analyzer	\$4,000
HP 3456A, Digital Multimeter	\$600	Tek 492BP, Spectrum Analyzer	\$8,500
HP 346A, Noise Source, 10MHz-18GHz	\$800	Tek 496P, Programmable Spectrum Analyzer	\$4,000
HP 3468A, Multimeter, 5.5 Digits	\$400	Tek 604, XY Monitor	\$100
HP 35689A, S-Parameter Test Set for 3589A	\$1,400	Tek 7020, Programmable Digitizer PI	\$600
HP 3582A, Spectrum Analyzer, .02-25.5KHz	\$1,800	Tek 7511, Sampling Unit w/S4 Head, DC-14GHz	\$800
HP 4140B, Picometer, DC Source	\$2,000	Tek AM503/A6302, Current Probe, Amp & Power Supply	\$800
HP 4274A, Multi-Frequency LCR Meter, Opt. 001,002,003	\$3,000	Tek DC503, Universal Counter Timer TM500	\$100
HP/IB, Includes Test Fixture	\$3,000	Tek DC504, Counter/Timer TM500	\$100
HP 435B, Power Meter	\$350	Tek DM502A, Autotracking DMM	\$150
HP 436A/022, Power Meter, HP/IB	\$800	Tek FG501, Function Generator, 1MHz	\$100
HP 5005B, Signature Multimeter	\$350	Tek FG502, Function Generator, 1Hz-11MHz	\$250
HP 5006A, Signature Analyzer	\$300	Tek P6046, Differential Probe	\$300
HP 5316A, Universal Counter, Opt. 004	\$200	Tek P6201, FET Probe Kit, 900MHz	\$400
HP 5334A/020, Universal Counter w/DMM	\$600	Tek P6202A, FET Probe, 500MHz unused	\$300
HP 5335A/010, Frequency Counter	\$600	Tek P6602, Temperature Probe for DM5110, DM511	\$150
HP 5335A/030, Frequency Counter, 1300MHz	\$800	Tek PG506, Scope Cal System w/FG501, SG503	\$1,500
HP 5340A, Frequency Counter, 18GHz	\$600	Tek PG508, Pulse Generator, 50MHz	\$300
HP 5340A, Frequency Counter w/Opt. 01/02/011	\$800	Tek PS503A, Dual Power Supply	\$150
HP 5342A, Microwave Counter	\$1,000	Tek SC502, Scope, 15MHz, Dual Trace	\$200
HP 5345A, Frequency Counter, Opt. 012	\$400	Tek SG502, Sig. Gen. 5Hz-50KHz	\$200
HP 5350A/010/002, Microwave Frequency Counter	\$2,000	Tek TDS410, Digitizing Oscilloscope, 150MHz	\$3,000
HP 54100D, Digital Scope, 1GHz	\$2,000	Tek TDS410A, Digitizing Scope, 200MHz, Opt. 13,1F	\$3,800
HP 54200A, Digital Storage Scope	\$800	Tek TG501, Time Mark Generator	\$200
HP 54601A, Digital Scope, 100MHz, 4 Channel	\$1,600	Tek TM503, 3 Slot Power Module	\$100
HP 6112A, Power Supply, 0-40V, 0.5A	\$200	Tek WM490A, Waveguide Mixer, 26.5-40GHz	\$800
HP 8015A, Pulse Generator, 1Hz-50MHz, 30V	\$500	Tek WM490K, Waveguide Mixer, 18-26.5GHz	\$800
HP 8165A, Programmable Signal Source, .0001-50MHz	\$1,000	Tek YK-1, Chart Recorder, 1500/B/C TDRs	\$500
HP 8165A, Programmable Signal Source, Opt. 02/03	\$1,200	Texscan SSG2000, Freq. Syn., 100KHz-2GHz	\$1,800
HP 8350B, Sweep Oscillator Mainframe	\$2,000	Ungar 4624, Solder, Desolder Station	\$250
HP 83540A, RF Plug-In, 2-8.4GHz	\$1,200	Vaihall 2000, Auto Digital Watt-Ammeter	\$200
HP 83545A, RF Plug-In, 5.9-12.4GHz	\$1,200	Vu-Data 5110, Semiconductor Tester, In/out Circuit	\$150
HP 83592C, RF Plug-In, .01-20GHz	\$8,000	Wavetek 166, Pulse Function Generator, 50MHz	\$500
HP 8410C/8412B, Network Analyzer	\$800	Wavetek 178, 50MHz Programmable Waveform Syn.	\$1,000
HP 8411A/Opt. 18, 18GHz	\$800	Wavetek 180, Sweep/Function Generator	\$200
HP 8411A, Frequency Converters	\$250	Wavetek 185, Sweep/Function Gen., .0001-5MHz	\$400
HP 8414A, Polar Display	\$100	Wavetek 186, 5MHz Phase Lock Generator	\$200
HP 8444A, Tracking Generator	\$650	Wavetek 1084, Signal Gen. Sweeper, 3.5-4.5GHz	\$300
HP 8445B, Spectrum Anyz., Automatic Pre-Selector	\$300	Wavetek 1910, XY Monitor, Dual Trace	\$400
HP 8447E, Amplifier, 1-1300MHz Gain 22dB	\$600	Wavetek 452, Filter, Dual HiLo, 1Hz-10KHz	\$450
HP 8481H, Power Sensor, 18GHz, 3 watts	\$400	Wavetek 7530A, FFT Spectrum Analyzer 0-100KHz	\$500
HP 8501A, Storage Normalizer, w/8501A & 8503A, Opt. 05	\$4,000	Wavetek 907, Signal Generator, 7-11GHz	\$600
HP 8502B, Directional Bridge, 10MHz-26.5GHz	\$1,200	Wavetek 955, Micro Source, 7.5-12.4GHz, AM, FM, Sweep	\$1,000
HP 85027B, Directional Bridge, 10MHz-26.5GHz	\$1,200	Wiltron 560A, Network Analyzer	\$800
HP 8514B, S-Parameter Test Set, 45MHz-20GHz	\$10,000	Wiltron 560-7K50, RF Detector, 10MHz-40GHz	\$400
HP 8557A/180TR, Spectrum Analyzer, .01-350MHz	\$1,000	Wiltron 560-97A50, SWR Autotester, .01-18GHz	\$500
HP 8558B, Spectrum Analyzer, .1-1500MHz	\$1,800	Wiltron 610D, Sweeper Mainframe	\$250
HP 8558A/182T, Spectrum Analyzer, .01-21GHz	\$2,500	Wiltron 610D/6237D, Sweep Generator, 2-18GHz	\$800
HP 8558A/853A, Spectrum Analyzer, Digital, .01-21GHz	\$3,500	Wiltron 6213D, RF Plug-In, 10MHz-4.2GHz	\$400
HP 8565A, Spectrum Analyzer, .01-22GHz, Opt. 100	\$4,000	Wiltron 6219D, RF Plug-In, 2-8GHz	\$200
HP 8569A, Spectrum Analyzer, 10MHz-22GHz	\$5,000	Wiltron 6223D, RF Plug-In, 4-12.4GHz	\$250
HP 86220A, RF Plug-In, 10-1300MHz	\$500	Wiltron 6229D, RF Plug-In, 7.9-18.5GHz	\$300
HP 86241A, RF Plug-In, 3.2-6.5GHz	\$400	Wiltron 62FF75, VSWR Bridge, 10-1000MHz	\$150
HP 86260A, RF Plug-In, 12-18GHz	\$400	Wiltron 6NF50, Autotester, 1-1500MHz, for 640	\$100
		Wiltron 7B50, Detector, 1-1500MHz, for 640	\$100

**MONTHLY CLEARANCE SALE**  
HP 3325A PROGRAMMABLE FREQUENCY SYNTHESIZER, .001Hz-21MHz, 11 DIGIT DISPLAY, HP/IB PROGRAMMABLE, OUTPUT 1mV-10V INTO 50Ω. **\$795**

## PHELPS INSTRUMENTS

2631 Hillside Ave., Norco, CA 91760  
909-279-7347 • FAX 909-279-7323



# TECH FORUM

Continued from page 67

The cost is \$70.00 for the 12 VDC model.

Thomas A. Frank  
Middletown, RI

## ANSWER TO #5992 - MAY 1999

*Whatever happened to McGee Radio in Kansas City, MO?*

I work in Kansas City, and I have been told they went out of business a few years back. There is no telephone listing either.

Breck Ricketts  
via Internet

## ANSWER TO #5996 - MAY 1999

*I want to interface my music CD changer to my PC.*

Do music CDs have a header containing the title and catalog number and does each track have a similar header with the song title?

No, music CDs do not have ASCII title or track information. Programs that play CDs on a computer use the number of tracks and their track times to compute a hash code that will uniquely identify most CDs.

The program asks the user to supply the artist, title, and track information for that CD, and then the program saves the information in a file. When a CD is inserted, the program computes the hash code and checks the file. If the hash code is in the file, then the program assumes it is the same CD and displays the previously entered information.

A hash code has a good chance of being unique. A simple hash would use the last digit of each track duration. The last digit is essentially random, so the odds that two seven-track CDs have the same hash code is 10 million to 1.

Microsoft's Media Control Interface (MCI) apparently computes a 24-bit hash code where the odds of a collision are 16 million to 1. You can access this code with the MCI "info cdaudio identity" command. See the Multimedia Programmer's Reference help file for details about the MCI calls.

The Microsoft CD Player applica-

tion uses this hash code (in hexadecimal format). The program's database is the text file C:\Windows\CDPlayer.ini.

For example, Suzanne Vega's Nine Objects of Desire has 12 tracks and hashes to D80665. The .ini file uses D80665 as the key, and then has several lines of data for the artist, album title, and track titles.

Ideally, the hash code to the album information could be downloaded from the net, but I don't know if anyone does that.

Gerald Roylance  
Mountain View, CA

## ANSWER TO #5993 - MAY 1999

*How do I set up equipment to determine the resonant frequency of a capacitor in the .001-.01 uF range?*

Measuring the self-resonant frequency of a capacitor requires a good test setup. The resonance is due to the capacitance and a series inductance.

For conventional capacitors, the wire leads supply most of the series inductance, and a good guess at this inductance is 20nH. 0.01uF capacitor will resonate at about 11 MHz. Any extra lead length in the test jig adds to the series inductance and affects the measurement.

The measurement is made by plotting the reactance of the capacitor versus frequency. At low frequencies, the capacitance determines the reactance.

The capacitive reactance decreases as frequency increases. At high frequencies, the inductance takes over. Inductive reactance increases with frequency. At resonance, the capacitive and inductive reactances cancel, and the measured reactance is a minimum (essentially zero).

In the test setup, a 50 ohm RF generator drives a series combination of a 50 ohm resistor and the capacitor under test. One end of the capacitor is grounded. A high-impedance scope measures the voltage across the capacitor.

# Do You Repair Electronics?

For only \$7.95 a month, you'll receive a wealth of information:

Repair data for TV, VCR, monitor, audio, camcorder, & more.

Over 100,000 constantly updated problem/solutions plus...

- TechsChat live chat room.
- UL/FCC number lookup.
- Private user discussion forums.
- Hot tips bulletin board.
- Automated email list server.
- Manufacturer information.

To access RepairWorld, direct your internet browser to <http://www.repairworld.com>

# RepairWorld.com

Electronix Corp. 1 Herald Sq. Fairborn, OH 45324 (937) 878-9878

Write in 101 on Reader Service Card.



# TECH FORUM

As long as the amplitude across the capacitor is small compared to the amplitude of the generator, then the generator is properly terminated and the voltage across the capacitor is proportional to its impedance.

If the generator is 5V and the voltage across the capacitor is 0.1V, then the reactance is 50 ohms  $(0.1V/5V) = 1 \text{ ohm}$ .

If you plot the impedance versus frequency on log-log paper, then you can get a good estimate for the resonant frequency. You can also just look for a minimum, but low signal levels and harmonic distortion make locating the minimum difficult unless you have a sensitive tuned detector.

I measured a 0.047uF 200V mylar to have a self-resonant frequency of about 6 MHz. At 5.4 MHz, the reactance was 0.34 ohms.

Gerald Roylance  
Mountain View, CA

## ANSWER TO #5998 - MAY 1999

I have an old Electron alert tone receiver made in 1970. Inside, I found only one crystal, but not the receive frequency of 154.43 MHz.

How can I change the frequency to receive the NOAA severe weather alert tones.

The crystal is for the local oscillator which differs from the receive frequency by the intermediate (IF) fre-

quency. You will need to replace the crystal with one that has the same difference from the frequency you want to receive.

The RF front end may be broad enough to cover the new receive frequency, but retuning won't hurt if you know what you are doing.

Russell Kincaid  
Milford, NH

## ANSWER TO #5995 - MAY 1999

I have a Masco three-channel amp. (Circa 1947.) Each mike input uses a 7B4 tube with 15 megohm grid resistor to GRND.

Can I use a 500Ω impedance mike on the input?

If you connect a 500 ohm microphone to the grid circuit on your tube amp, you will likely find that the audio level is too low. Also, the grid circuit is unbalanced in relation to ground (just one signal wire), which makes the input susceptible to hum and noise pickup.

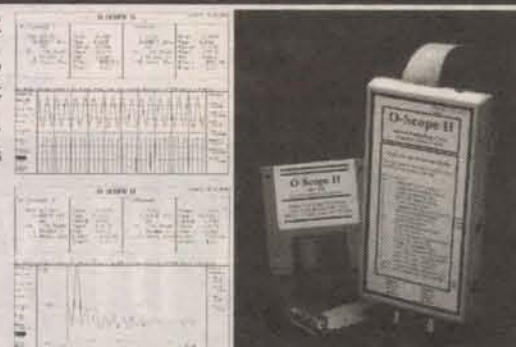
The microphone circuits on tube amps generally fell into one of two categories. Either they had a high impedance input, for direct connection to a high-impedance mic, or they had an audio transformer in the input circuit, for connection to a low-impedance mic.

The transformer served to step up the voltage from the low imped-

# Digital Storage Oscilloscopes From \$99.00

ATC modules turn your PC into a full-function DSC, spectrum analyzer, logger, & DVM. Units DC to 50MHz. O-Scope II now in Windows 3.1, 95/98, NT and DOS.

O-Scope Ip \$189.  
O-Scope II \$349.  
Specialty probes call.



ATC is a stocking distributor for Pico Technology LTD which offers scope modules to 100MSPS, resolutions from 8 to 16 bit.

Pico offers PC based data loggers from 1 to 22 channels, 8 to 16 bit and the Enviromon environmental monitoring system.

Pico products - call

The DFA-5, low cost differential amplifier, cuts through common mode noise problems to reveal low voltage signals. With gains from 1X to 1000X and band widths from 20KHz to 1.2MHz, DFA-5 is the test accessory to help you work with signals from 5 Volts to 5 microVolts. Only \$129.00.

NEW  
DFA5

Serial Port Problems ???  
Check out Serial !! Our lowcost serial channel analyzer only \$99.00.

Allison Technology Corporation

2006 Finney Vallet Rd., TX. 77471 U.S.A.

800-980-9806 or 281-239-8500

<http://www.atcweb.com> atc@accesscomm.net

# BRIGAR ELECTRONICS

7-9 ALICE ST.  
BINGHAMTON, NY 13904

PHONE: (607) 723-3111  
FAX: (607) 723-5202  
E-MAIL: BRIGAR2@aol.com

ENTER OUR WEB SITE AT

<http://members.aol.com/brigar2/brigar.html>

NMB 12 VOLT DC FAN 28 CFM  
Model # 3110KL-04W-B17  
0.13 Amp - 7 blade - DC Brushless -  
Phenolic Blade & housing -  
3.15" SQ. x 1" TH  
Ball bearing -  
12" wire leads -  
UL & CSA -  
Noise: 25 (dba) -  
BRIGAR PRICE  
.... \$4.25



BIPOlar Power Transistor  
RCA #MJ15018  
18 AMP 120V 180W  
Metal can -  
house marked  
#132152  
TO-204  
PACKAGE  
PRICE... \$1.50



10 pcs. & up  
\$1.00 ea.

NEVER Loose Your Keys AGAIN  
For those of us who can never remember where we put our keys. Now you can buy extra memory  
Brigars Exclusive simm chip key chain  
\$ 2.95 ea.

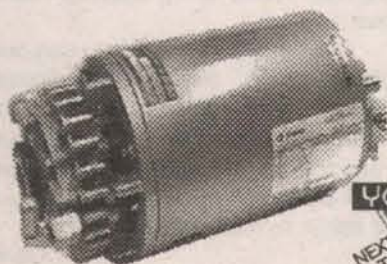
Note: If you need over 4 meg consult your physician.



AC TO DC Wall TRANSFORMER  
MFG: AUDIOVOX # CNR405  
INPUT: 120VAC 60Hz 11W  
Output: 12 VDC 300mA  
Polarity: Center pos. complete  
with 6' zip cord  
2.5 mm Female  
receptacle.  
UL & CSA  
APPR.  
SALE PRICE  
... \$ 1.50



ROTARY VANE AIR COMPRESSOR  
GAST Model# 0522-P167-G451DX  
Oil-less rotary vane air compressor directly  
connected to motor. Compressor rated at  
3.2 to 4 Cfm @ 10 psig max.  
Motor rating:  
3/4 H.P. 60 Hz 115 Vac 1 PH 1725 RPM  
Code H - 7.40 A - SF 1.00 - FR 56 Cz Amb 50 c  
Time Rating: Cont. Insul Class B - Thermally Prot.  
Motor Size: 14"L X 6-1/2"Dia. Weight: 40 Lbs.  
Shaft Size: 2-1/8"L x 5/8"dia. (Flated)  
BRAND NEW FACTORY BOXED ..... \$119.95



YOU PAY  
NEXT  
TO  
NOTHING

BAR-CODE HANDY TERMINAL  
MFG: Nippondenso co.  
Bar-code reader stores information,  
then cable to computer to Down  
Load. Comes complete with user  
guide and computer cable. High  
speed battery charger #C-200 also  
included. Brand New Factory  
Boxed. Model # BHT-4082  
SALE PRICE...  
\$ 599.95



SAVINGS  
Below

AIR COMPRESSOR - 35 PSI PRESSURE  
Mfg: Thomas Motor Driven diaphragm unit.  
Rated 35 PSI - 0.05 SCFM int. duty  
(20 PSI @ 0.30 SCFM Cont. duty)  
Motor Input: 115 Vac 60 Hz 0.75Amp  
Ports IN & Out: 1/8" FNPT  
Size: 7"L x 5-1/2"H x 4-1/4"W  
Weight: 10 LBS (RFE MINT COND)  
Part #  
107CE20-906  
SALE PRICE...  
\$69.95



MALLORY SONALERT II  
Audible signal Device  
Voltage: 3-20 vdc  
current 3-16 mA  
Size: 23 mm lbs. 3 grams  
Resonant Freq: 3.4 KHz  
90 dB at 20 vdc  
Applications: Fire Alarm  
Crime Prevention alarm,  
Call Buzzer, Automotive,  
Clocks, Electrical Inst. etc...  
Part # MS0320  
Price ... \$1.50





**Metric**  
Equipment Sales, Inc.

800-432-3424  
Fax: 510-264-0886  
www.metricsales.com

**RENT • BUY • SELL**  
Yes, we will buy your surplus equipment!

**Scopes, Meters, Analyzers, Power Supplies, Signal  
Generators, Counters, Recorders and more**

Hewlett-Packard, Tektronix, Fluke, Dranetz, TTC, Anritsu,  
Wavetek, Keithley, and more

**Test & Measurement Instruments**

Over 7000 Models • 6-Month Warranty  
Save 30-90% • 5-Day Free Trial

Write in 104 on Reader Service Card.

## Control High Security Access with a Unique TRANSPONDER KEY



**The ideal security solution for an infinite number of applications**

The proximity technology employed by our unique transponder kit permits the transfer of data between the keyfob and the transmitter/receiver when the key is within range, up to 70mm. The list of applications for which the kit may be used is literally endless.

AS LOW AS  
**\$9.00**  
PER UNIT\*

\*10,000 UNITS  
One (Sample) \$25  
50+ units \$18 each  
100+ units \$16 each  
500+ units \$15 each  
1000+ units \$12 each  
10,000+ units \$9 each  
— Plus S&H —

- Security Authorization
- Home or Office Security Entrance
- Gate Access Control
- Private Parking
- Entrance to restricted areas
- Restricted elevator call
- Alarm Systems
- Etc.

**Includes simple schematic diagrams for connecting a pulse relay and 'on' switch**  
to enable activation of—for example—an alarm system and door opener

**SPECIFICATIONS:** Circuitry housing: Black plastic 4 1/8" x 2 1/8" x 1". Sensor: Extends 19" from housing, size 2 1/8" x 5/8" x 1/4". Detects key up to 2.75" through wood, glass, or plastic. Keys: Comes with 2 keys. Waterproof, crush resistant. Power: 12VDC. Standby mode 21Ma, Detection Mode 48Ma

**TO ORDER - CALL OR FAX**  
Tel. 914-352-5053 • Fax 914-426-5374

A.S. Electronics • P.O. Box 601 • Monsey, NY 10952 914-352-5053

## TECH FORUM

ance mic, providing a better signal-to-noise ratio. (Most professional mics were 125 to 150 ohms, although some were in the 50-ohm range.) Most low-Z inputs were balanced, which greatly reduced hum and noise problems.

Of course, a transformer won't increase the power output from the mic, but it will increase the voltage. The transformer's voltage ratio (secondary/primary) is equal to the square root of the impedance ratio (secondary/primary). So a transformer with a 500 ohm primary and a 10K ohm secondary will have a voltage step-up of roughly 4.47, that's roughly a 13 dB increase in voltage, which will provide a corresponding improvement in S/N ratio.

Because of the very low levels and high gain involved in a microphone input, the input transformer will almost surely need to have magnetic shielding to prevent pickup of hum or other unwanted signals. Keep the input transformer away from the power and audio output transformers.

You may need to adjust the physical orientation of the transformer, too, for lowest noise.

Good, broadcast-quality mic transformers, with flat frequency response and low distortion, are quite expensive. I found a few low-cost alternatives that you could try.

RadioShack sells an in-line mic matching transformer, with a standard XLR connector on the Low-Z primary, and a standard 1/4" phone plug on the Hi-Z secondary. Part #274-016; price around \$15.00.

TechAmerica sells a miniature transformer with solder terminals. They list it as 100K ohm primary and 600 ohm secondary; just connect it in reverse for your application. Part #900-5844; price around \$15.00.

Mouser Electronics sells a range of suitable transformers made by MagneTek. For example, stock #553-SP4 is listed as 200K ohm primary and 1K ohm secondary (again, connect it in reverse); price around \$21.00.

Greg Miller  
State College, PA  
gemiller@commedge.com

### ANSWERS TO #59915 - MAY 1999

*I am a high school student interested in working with infrared video.*

*Does anyone know of a source for infrared video cameras?*

You should check the Advertisers Index, under Cameras. Resources Un-Ltd. is the best bet at 1-800-810-4070, as they have a lot of military surplus.

John M. Hoyt  
Easley, SC

### ANSWERS TO #59915 - MAY 1999

*If you are talking about infrared light, then most of the \$40.00 small black and white board cameras are*

sensitive to infrared light.

Just illuminate the area with light from a bunch of infrared LEDs or get an illuminator already built. However, if you are wanting to pick up infrared, HEAT images, that's a very different story, they start around \$1,000.00 and up, way up.

Breck Ricketts  
via Internet

### ANSWERS TO #59915 - MAY 1999

Depending on what you mean by infrared, you can purchase numerous cameras from the suppliers in *Nuts & Volts* and they are called "CCD Black and White" cameras.

Any solid-state B&W camera covers a part of the infrared spectrum and can be used with IR lasers or LEDs as a lighting source.

These cameras start at a very reasonable price of around \$60.00 and some even come complete with both the lens and a casing for a little more.

The frequency response of these cameras run into the low side of the infrared spectrum however, and if you seek a higher frequency of infrared, say above the 1100 nm range, then expect to pay thousands of dollars for a complete camera or IR viewer.

However, you can build an "IR Viewer" for less than a couple of hundred bucks and add a B&W camera to its output viewer screen to achieve the higher "IR spectrum" past the 1100 nm range.

Chris  
Bieber, CA

### ANSWER TO #5997 - MAY 1999

*I have a DPDT switch that forward and reverses a 12 VDC, 3 amp motor with limit switches that control in and out positions. I want to replace the switch with an RF transmitter and receiver.*

*I need additional circuitry to make it work the same as the DPDT switch. A garage door opener does what I want except it controls an AC motor.*

Actually, the garage door opener relay will work in the AC or the DC mode. The relay itself will operate from AC or DC as long as the voltage is high enough to pull down the windings. The switch part of the relay will carry either AC or DC as long as the current doesn't exceed its ratings.

Smaller DC and solid-state relays can also be found that will operate from as low as 3 volts DC with 5- and 12-volt models being the most common.

To simplify matters, you can purchase a DPDT relay that will directly replace your switch and they also come in the popular voltage and current ratings that you seek. Digi-Key at 1-800-344-4539 has 19 pages of relays to choose from.

Chris  
Bieber, CA



**CALL TOLL FREE**

(800) 292-7711

Orders Only

Se Habla Español

# C&S SALES

**Excellence in Service**

**CALL OR WRITE  
FOR OUR  
FREE**

**64 PAGE CATALOG!**

(800) 445-3201

## Digital Multimeters

### Elenco Model M-1740



**\$39.95**

- 11 Functions:**
- Freq. to 20MHz
  - Cap. to 20µF
  - AC/DC Voltage
  - AC/DC Current
  - Beeper
  - Diode Test
  - Transistor Test
  - Meets UL-1244 safety specs.
- Model M-2760 - \$24.95**  
(9 functions)

### Elenco Model LCR-1810



**\$99.95**

- Capacitance .1pF to 20µF
- Inductance 1µH to 20H
- Resistance .01Ω to 2000MΩ
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

### Fluke 87III



**\$299**

Features high performance AC/DC voltage and current measurement, frequency, duty cycle, resistance, conductance, and capacitance measurement.

Series II (limited qty.)  
**\$289**

## Generators and Counters

### Elenco Sweep Function Generator with built-in frequency counter Model GF-8036



**\$225**

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

### 20MHz Sweep / Function Generator with Frequency Counter Model 4040

**\$399**



- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep

**BK PRECISION**

**10MHz Model 4017 \$309**

**5MHz Model 4011 \$239**

### Elenco Handheld Universal Counter 10Hz - 2.8GHz Model F-2800



**\$99**

- Sensitivity:**
- <1.5mV @ 100MHz
  - <5mV @ 250MHz
  - <5mV @ 1GHz
  - <100mV @ 2.8GHz

Features 10 digit display, 16 segment and RF signal strength bargraph. Includes antenna, NiCad battery, and AC adapter.

### Elenco RF Generator with Counter (100kHz - 150kHz) Model SG-9500



Features internal AM mod. of 1kHz, RF output 100mV - 35MHz. Audio output 1kHz @ 1V RMS.  
**SG-9000 (analog, w/o counter) \$119.95**

### B&K Frequency Counter Model BK-1875



**1Hz - 2.8GHz  
3 Channels  
\$189**

- Sensitivity:**
- <0.8mV @ 100MHz
  - <6mV @ 300MHz
  - <7mV @ 1GHz
  - <100mV @ 3GHz

Ultra sensitive synchronous detector bargraph and RF strength.

### Elenco 10Hz - 1MHz Digital Audio Generator Model SG-9300

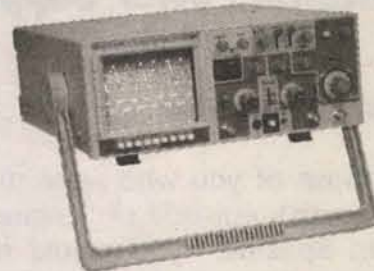


**\$175**

Features built-in 150MHz frequency counter, low distortion and sine/square waves. **SG-9200 (w/o counter) \$119.95**

## Elenco Oscilloscopes

Free Dust Cover and 2 Probes



S-1325	25MHz	Dual Trace	\$325
S-1330	25MHz	Delayed Sweep	\$439
S-1340	40MHz	Dual Trace	\$475
S-1345	40MHz	Delayed Sweep	\$569
S-1360	60MHz	Delayed Sweep	\$749
S-1390	100MHz	Delayed Sweep	\$995

### DIGITAL SCOPE SUPER SPECIALS

DS-203	20MHz/10Ms/s	Analog/Digital	\$695
DS-303	40MHz/20Ms/s	Analog/Digital	\$995
DS-603	60MHz/20Ms/s	Analog/Digital	\$1295

## Four Functions in One

### Elenco Model MX-9300



**\$459.95**

### Features:

- One instrument with four test and measuring systems:
- 1.3GHz Frequency Counter
- 2MHz Sweep Function Generator
- Digital Multimeter
- Digital Triple Power Supply - 0-30V @ 3A, 15V @ 1A, 5V @ 2A

## Tekk Radios

### Pro-Sport FRS Two-Way Radio Model PRO-SPORT+

- 14 Channels
- Battery Monitor
- Key Lockout
- Monitor Button
- Lightweight
- Palm Sized
- Large LCD Display
- Removable Belt Clip
- Removable Antenna
- Two Radio Call Tones
- Busy Channel Lockout
- Accessory Connector
- Highly Water Resistant

**\$79 each**  
**or**  
**\$149.95**  
Set of 2

Talk up to 2 miles!



**PRO SPORT Model**  
**\$109.95 set of 2**

## Miscellaneous

### Elenco Technician Tool Kit Model TK-1500

**\$49.95**

28 tools plus a DMM contained in a large flexible tool case with a handle ideal for everyone on the go.



### Elenco Quad Power Supply Model XP-581



**\$89.95**  
**4 Fully Regulated DC Power Supplies in One Unit**  
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A  
1 Variable - 2.5 - 20V @ 2A

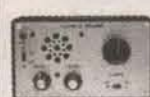
### Dual-Display LCR Meter w/ Stat Functions B&K Model 878



**\$219.95**  
Auto/manual range  
Many features  
with Q factor  
High Accuracy

## Elenco Educational Kits

### Model AR-2N6K



2 Meter / 6 Meter  
Amateur Radio Kit  
**\$34.95**

### Model AM/FM-108K



Transistor  
Radio Kit  
**\$29.95**



**Model AK-700**  
Pulse/Tone  
Telephone Kit  
**\$15.95**



**Model AK-870**  
Radio Control Car Kit  
• Solderless  
• 7 Functions  
• Radio Control  
Included  
**\$24.95**



**Model M-1005K**  
Digital Multimeter Kit  
• 18 Ranges  
• 3 1/2 Digit LCD  
• Transistor Test  
• Diode Test  
**\$19.95**



**Model XP-720K**  
Power Supply Kit  
• 1.8VDC - 18VDC @ 1A  
• -1.8VDC - -18VDC  
• 5VDC @ 2A  
• 6.3VAC @ 1A and  
12.6VAC center  
tapped @ 1A  
**\$54.95**



**Model XK-150**  
Digital / Analog  
Trainer  
**\$89.95**



**Model EP-50**  
Electronic  
Playground and  
Learning Center  
**\$19.95**

**Guaranteed Lowest Prices**

UPS SHIPPING: 48 STATES 5%  
OTHERS CALL FOR DETAILS  
IL Residents add 8.25% Sales Tax

**SEE US ON THE WEB**

**C&S SALES, INC.**

150 W. CARPENTER AVENUE  
WHEELING, IL 60090

FAX: (847) 541-9904 (847) 541-0710

→ <http://www.cs-sales.com>



**15 DAY MONEY BACK GUARANTEE**

**2 YEAR FACTORY WARRANTY**

PRICES SUBJECT TO CHANGE WITHOUT NOTICE



# STAMP APPLICATIONS

by Lon Glazner

## Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

### Dual Digital Power Supply — Part 2

#### Overview

For those of you who were tuned into last month's episode of "Engineers With Brain Spasms," you would have seen me go through the process of defining a user interface for a digitally-controlled power supply. The user interface went together pretty quickly and with relatively little pain. I wish I could say the same about this month's power supply design. I went to great lengths to keep the design as simple as possible, and was thus hampered by my own design constraints. That being said, I feel that there are quite a few useful bits and pieces that can be filtered out of the final product.

So even though I came close to scrapping this implementation of a digitally-controlled dual power supply at least five times over the last month, in the end I felt that it provided enough useful information to push it through to completion.

In electronic design, there are a few fields that are clearly viewed as arcane arts by engineers not employed in those fields. A sampling of these disciplines would include radio frequency design, high-speed digital design, antenna theory and, of course, switching power supply design. I don't pretend to be an expert in any of those fields. So, when it came time to design a power supply circuit for this article, I made sure to make use of circuits that were relatively simple. The power supply circuit that I used is inexpensive, requires

few parts, and is extremely useful. I have found this circuit to be quite useful in previous designs, although its effectiveness in this particular design was somewhat limited.

I also felt that this article should focus on implementing a digital control technique in conjunction with a user interface. I was wary of introducing too many new electronic components, and thus making the article too difficult for beginners to understand. Given the amount of space I have available, it's very difficult to provide an accurate overview of a design if I have to describe in detail a large number of electronic parts. What's the point of my diatribe you ask? Well, in order to keep things simple, I resorted to using the DS1267-010 Dallas Semiconductor digital potentiometer, and the ADC0831 National Semiconductor eight-bit A/D. Both of these parts were used in the April '99 Stamp Applications article. So, if you are a regular reader, you should be familiar with those parts. But by selecting these parts, I placed some serious limitations on the power supply's capabilities.

#### Defining the Design

In my initial design, I was shooting for a digitally-controlled dual power supply with an output range of 3-20V and about 2A current source capability. A linear regulator, such as the National Semiconductor LM317, could be used. But if I used a linear regulator, cooling and heatsinking would be mandatory. For example, an 8Vdc output linear regulator, providing 500mA of current, with an input voltage of 24Vdc would have to dissipate  $(24\text{Vdc} - 8\text{Vdc}) \times 0.5\text{A} = 8\text{ watts}$ . Even with external pass elements, I would have to account for considerable power dissipation.

On the other hand, a switching power supply would provide me with the efficiency necessary to minimize power dissipation concerns. It was primarily due to power dissipation considerations that I selected the MAX726 (Maxim Integrated Products: 1-800-998-8800 for samples) step-down, PWM, switch-mode DC-DC

regulator, as a power supply. You can approximate the power dissipation requirements for the MAX726 by multiplying the load current by 1.1Vdc. This is described in the MAX726 data sheet. Therefore, by using a MAX726 instead of a linear regulator, your 8Vdc supply would only have to dissipate  $1.1\text{Vdc} \times 0.5\text{A} = 0.55\text{ watts}$ ; which is a significant improvement over the linear regulator.

Furthermore, the MAX726 has an output voltage range of

2.5Vdc-35Vdc, and the ability to source 2A of continuous current. Package power dissipation should still be addressed at higher load currents. These features coupled with some internal short circuit protection make the MAX726 ideal for this design.

But how do you adjust the output voltage with this regulator? Take a glance at Figure 1. From the MAX726 data sheet, I know that the output voltage is selected by R7 and the value of the potentiometer. I also know from the equation for a voltage divider that the feedback voltage at pin 1 of the MAX726 can be described by

$$V_{fb} = V_{out} \times (R_{pot} / (R_{pot} + R_7))$$

But unlike your average voltage divider, the feedback voltage,  $V_{fb}$ , is pre-set to 2.21Vdc internally by the MAX726. This has two important effects on our design. The first effect is that with  $V_{fb}$  set to 2.21V, the current through our digital pot will not exceed its maximum rating (5mA). Additionally, the voltage on our digital pot is kept within its specifications (7Vdc maximum). All in all, it means that a digital pot is an effective means of adjusting the output voltage

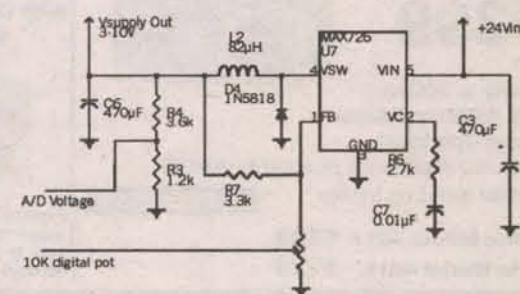


Figure 1: Power Supply Circuit

generated by the MAX726.

There are a few points that must be stated here. The digital potentiometer (DS1267-010) was very effective in controlling the output voltage of the MAX726 over a short range of voltages. Specifically, I had luck controlling the MAX726 between 3Vdc-10Vdc. Over 10Vdc, there was not enough resolution available in the DS1267-010 to allow accurate voltage control. So at this point, I reduced the power supply output to 10Vdc maximum, and modified the user interface code to reflect this change. I also realized that whenever I reduced the output voltage below 4Vdc, I was violating a recommendation in the MAX726 data sheet. The data sheet specifically states that the resistor between the FB pin and ground should not exceed 4K ohms (this is where the DS1267-010 is located). In this system, any voltage output between 3Vdc and 4Vdc is generated by a DS1267-010 setting of greater

## SOLUTIONS TO YOUR CABLING NEEDS

Cat.5 -- Enhanced Cat.5 -- USB -- IEEE1284 / 488 / 1394  
Firewire -- High-End Monitor -- Manual & Auto Switches  
Apple -- Custom Cables -- Premise Wiring -- more!  
HUGE SELECTION OF SCSI CABLES & ADAPTERS

### FIREWIRE Cables


EC63AV-2M.....6-to-4 pin, 6 feet.....\$30.00  
EC63AV-3M.....6-to-4 pin, 10 feet.....\$35.00  
EC63AV-5M.....6-to-4 pin, 15 feet.....\$40.00

### Reseller Specials

AMD K6 CPU cooler (BB).....\$3.25 (min 25)  
IEEE1284 Printer Cable 6ft.....\$3.60 (min. 20)  
\*\*\*See our website for photos & more\*\*\*

Order Online 24 hrs./day. Reseller & Qty. Discounts Available!


No minimum order, same day shipping on most orders, A+ and CET technician available to answer your questions

Northwest Cable & Connector Co.

www.nwcable.com

Phone: (360) 754-3606 Fax: (360) 754-0825



# STAMP APPLICATIONS

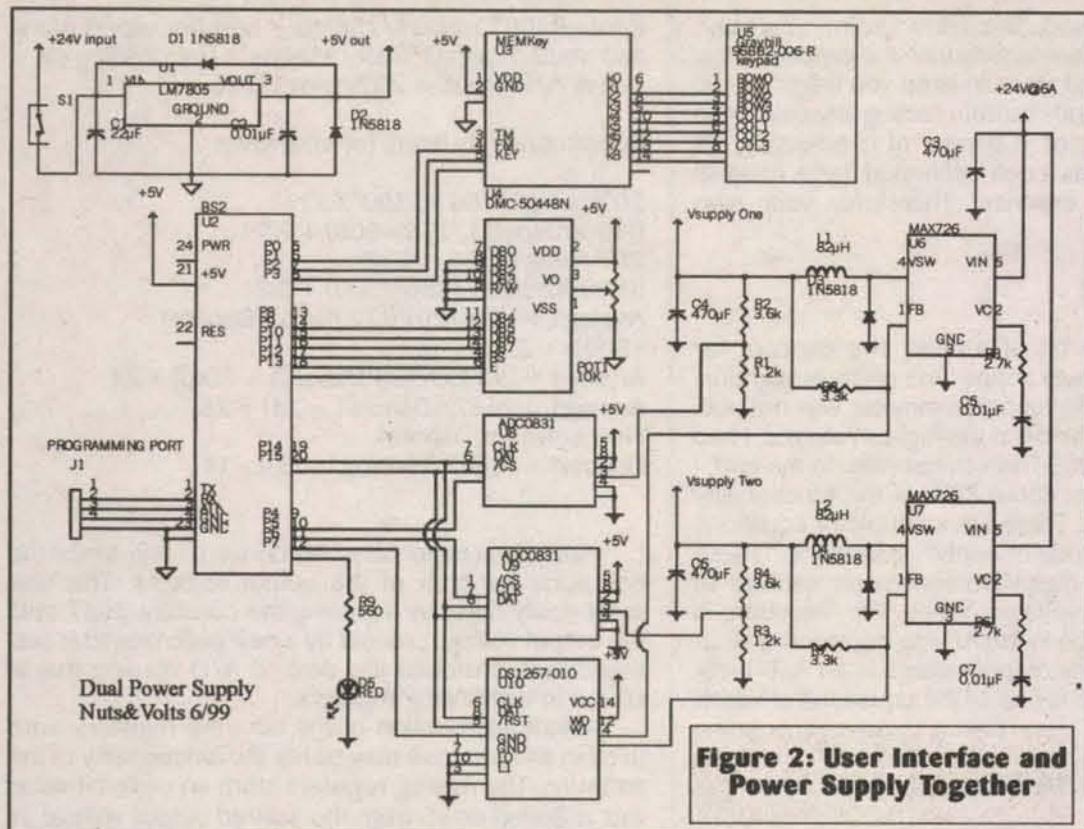


Figure 2: User Interface and Power Supply Together

than 4K ohms. I tested the voltages under load and didn't find any serious degradation in performance. So I left the minimum output voltage limit set to 3Vdc.

The limitations forced onto this design really did revolve around the capabilities of the DS1267-010. If, for example, the digital pot had 10 bits of resolution, then I think many of these shortcomings would disappear. But for simplicity and, due to a nearing publication deadline, I decided to press on with the design.

As part of a feedback system, I included two eight-bit A/D converters (ADC0831). So the way the system worked could be described in five steps.

- 1) The user enters the desired voltage output.
- 2) The BASIC Stamp2 (BS2) converts the desired output to a desired A/D reading.
- 3) The BS2 calculates an approximate setting for the digital potentiometer.
- 4) The BS2 measures the actual output voltage and trims the DS1267-010 until the desired A/D matches the actual A/D.
- 5) If the actual output voltage never matches the desired output voltage, then the user is notified, otherwise the system waits for the next user update.

The A/D inputs were originally read through a voltage divider circuit that divides down the actual output voltage by four. This was done in order to measure 20Vdc maximums with 5Vdc A/Ds. When I changed the output voltage range of the supply from 3Vdc-20Vdc to 3Vdc-10Vdc, I could have changed the voltage divider from a divide by four configuration to a divide by two configuration. Making this change would give greater resolution in the A/D measurement results. While this would be good, it doesn't change the fact that output voltage resolution is limited at higher output voltages due to the characteristics of the DS1267-010.

So, after all of the give and take, what is left over is a dual supply with 3Vdc-10Vdc regulated output and a 1A source capability. The current handling capability of this circuit was limited to 1A by the inductor selected.

## Connecting the Parts

The two ADC0831s and the DS1267-010 were all connected to the same clock and data lines. Each chip had a separate chip select control line. Using the LCD in four-bit mode — as well as the MEMKey for serial keypad encoding — freed up enough I/O lines to allow this design to get done. The MEMKey could be used in single wire communication mode by connecting the TM and FM pins together to one BS2 I/O pin. This would free up another I/O line. Also, if the out of regulation indicator LED was omitted from the design, then three I/O lines could be available for other use.

Program memory is pretty much used up at this point, although moving the design to a BS2SX would eliminate that problem. A complete system schematic is detailed in Figure 2.

## Power Supply Limitations

The major limitations of this power supply were imposed by using the DS1267-010. If I had this design to do over again, I would probably remove the digital potentiometer and add two 5K ohm mechanical potentiometers for voltage setting. Then you could change the eight-bit A/Ds to 10-bit A/Ds. You might even add a couple more A/Ds and some current measurement capability. The keypad could also be removed in lieu of a couple of buttons for selecting voltage or current displays. If you wanted to get really tricky, you could design an active load by biasing a BJT in its active region through adjustments to its base resistance. This could potentially replace the DS1267-010.

An important thing to consider when using the MAX726 is which inductor to use. The inductor is in the high current path. So your inductor must have a continuous current rating equal to, or greater than, the maximum load current that your supply will provide. An inexpen-

FOR THE BEST  
PRICES ON PROFESSIONAL TOOLS,  
CALL ELECTRO-TOOL



**platt** — Case — Deluxe Polypropylene. Chemical Resistant. Tools by CooperTools and others. 800T Case, complete with tools ... \$419.95  
800T Case Only ... \$121.80



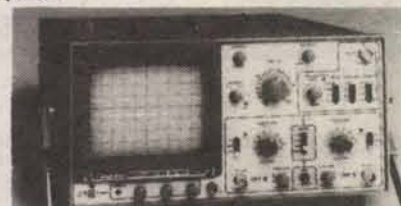
**platt** — Case — Cordura Exterior. Two exterior pockets & one literature pocket. 660ZT Case, complete with tools ... \$223.00  
660ZT Case Only ... \$59.45  
Optional Sperry meter #DM6510 as shown ... \$65.00



**Weller WCC100** — Electronically controlled station, temperature adjustable from 350°F-850°F, Zero voltage circuit-safe for sensitive components, 40 Watt pencil ... \$97.90

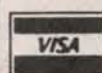


**OptiVISOR** — Superior magnification, Optical Glass Prismatic lenses (not plastic). Select any one of (6) magnifications ... \$24.00



**GoldStar** — 20 MHz Dual Trace Oscilloscope OS-9020A—Large 6" rectangular, high sensitivity: 1mV/div, high accuracy: ±3%, stable, low-drift design, 8 divisions of displayed dynamic range and accurate, distortion-free waveform measurements ... \$372.00

## Electro Tool, Inc.



9103 Gillman, Livonia, MI 48150  
Customer Service: (734) 422-1221  
ORDERS ONLY: 1 (800) 772-3455  
FAX: (734) 422-3432



"Tools American Made."

sive, relatively high current inductor is the Toko 8RHB type which can be found at Digi-Key. I had some 82uH inductors laying around which were rated for 1.1A, and they seemed to do the trick. There are higher current rated inductors that are available, but I really like the packaging of the Toko parts. They take up less room than some electrolytic capacitors.

Lastly, I didn't heatsink my MAX726 regulators. They handled about a watt of power (900mA load) without overheating. I used the three second test for my thermal modeling. The three second test consists of licking your finger and placing it on a potentially hot device. If you



## Learn MICROCONTROLLERS EMBEDDED SYSTEMS and PROGRAMMING...

with the AES learning system/  
embedded control system.  
Extensive manuals guide  
you through your  
development project.  
All programming  
and hardware details  
explained. Complete schematics.  
Learn to program the LCD, keypad  
digital, analog, and serial I/O. for  
your applications.



**THREE MODELS AVAILABLE.**  
Choose from an Intel 8051,  
Intel 8088, or Motorola 68HC11  
based system.  
All models come with:

- 32K Byte ROM, 32K Byte RAM • 2 by 16 Liquid Crystal Display • 4 by 5 Keypad • Digital, Analog, and Serial I/O • Interrupts, timers, chip-selects • 26 pin expansion connector • Built-in Logic Probe • Power Supply (can also be battery operated) • Powerful ROM MONITOR to help you program • Connects to your PC for programming or data logging (cable included) • Assembly, BASIC, and C programming (varies with model) • Program disks with Cross Assembler and many, well documented, program examples • User's Manuals; cover all details (over 500 pages) • Completely assembled and ready to use • Source code for all drivers and MONITOR • Optional Text Book

Everything you need. From \$279  
Money Back Guarantee  
Call for Free Info Pack, or see  
WEB at <http://www.aesmicro.com>  
714-979-1091, FAX 714-979-1093

Call 1-800-730-3232



AES 2110 S. LYON ST., STE. C, SANTA ANA, CA 92705 USA

# STAMP APPLICATIONS

hear a sizzle (that sounds like saliva turning to steam), then it would be prudent to withdraw the exposed digit. If no sizzle occurs, and you can keep your finger on the device for three seconds without feeling any pain, then the part is probably not in danger of overheating. Of course, my finger has been calibrated by a national laboratory at great expense. Therefore, your own results may vary.

## Writing the Code

The code was a bit of a bear. The concept for implementing this power supply was pretty straightforward. But since the digital potentiometer was not able to give me good resolution at the higher voltages, I had to throw in a slew of If...Then statements. In the end, I think I was able to get about 80% of the functionality that I was looking for. There are a couple of equations that I use in the "UpdateSupply" subroutine. These equations relate the digital potentiometer settings to the desired output voltage. When the equation is implemented, the value in the Analog register is a binary value that relates the output voltage to an A/D measurement result. Here is one of the equations of which I speak:

$$D\text{Spots1} = (2376 / (\text{Analog1} - 28)) - 14$$

And here is how it is arrived at. From the MAX726 data sheet, we know that the output voltage can be related to the digital potentiometer with the following equation:

$$V_{\text{out}} = (R7 + R_{\text{pot}}) * (2.21V / R_{\text{pot}})$$

where  
R7 = 3300 ohms

$$R_{\text{pot}} = 9000 * D\text{spots1} / 256\text{bits} + 500 \text{ (for wiper) ohms}$$

$$\text{and } V_{\text{out}} = \text{Analog1} * 5V_{\text{dc}} / 256\text{bits} * 4 \text{ (for dividing circuit at A/D input)} = 20 * \text{Analog1} / 256$$

Substituting this result for Vout gives ...

$$20 * \text{Analog1} / 256 = 3300 * 2.21 / ((9000 D\text{spots1} / 256) + 500) + 2.21$$

$$20 * \text{Analog1} / 256 = 7293 / ((9000 D\text{spots1} / 256) + 500) + 2.21$$

$$\text{Analog1} = (256 / 20) * ((7293 / (35 * D\text{spots1} + 500)) + 2.21)$$

$$\text{Analog1} = (93359 / (35 * D\text{spots1} + 500)) + 28$$

$$\text{Analog1} = 2667 / (D\text{spots1} + 14) + 28$$

Now solve for Dspots1...

$$D\text{spots1} = (2667 / (\text{Analog1} - 28)) - 14$$

After this relationship was derived, I fine-tuned the equations for both of the output voltages. This was most easily done by adjusting the constant 2667 until the output voltage created by a new potentiometer setting closely matched the desired A/D reading that is stored in the Analog registers.

A little explanation of the how the registers were used in this program may clarify the functionality of the software. The Analog registers store an eight-bit value that is boiled down from the desired output voltage as it is displayed on the LCD. This eight-bit value is then used to derive a value for setting the digital potentiometer, as described by the equations above. After the digital potentiometer has been updated, the program trims the output voltage by taking A/D readings (stored in AD\_in registers), and comparing them to the desired value (again in the Analog registers). Any readings that do not meet the requirements set forth in the program cause the potentiometer setting to be

### Code Listing 1: june99\_4.bs2

' JUNE99.BS2 - Dual power supply and user interface code listing. This source code implements a user interface consisting of a 2x8 LCD screen operating in 4 bit mode, and a 4x4 keypad. The LCD is driven directly with a BASIC Stamp 2 while the keypad is encoded by a MEMKey serial keypad encoder. LCD display data is stored in the MEMKey's user accessible EEPROM.  
' Further modifications to this code were included to implement a digitally controlled dual power supply. The supplies parameters were reduced from a maximum of 20.0V to 10.0V in order to maintain resolutions with eight-bit A/D and D/A (digital pot) devices.

' LCD constants  
RS CON 12  
E CON 13

' LCD control characters  
ClrLCD CON \$01  
CrsrHm CON \$02  
CrsrLf CON \$10  
CrsrRt CON \$14  
DispLf CON \$18  
DispRt CON \$1C  
DDRam CON \$80

' LCD Variables  
Char VAR Byte

' MEMKey pin assignments  
TM CON 0  
FM CON 1  
KEY CON 2

' MEMKey variables  
Index VAR Byte  
KeyVal VAR Byte  
B\_1 VAR Byte  
B\_2 VAR Byte  
B\_3 VAR Byte  
B\_4 VAR Byte  
B\_5 VAR Byte  
B\_6 VAR Byte  
B\_7 VAR Byte  
B\_8 VAR Byte  
B\_9 VAR Byte

' MEMKey constants  
Baud CON 396  
PConfg CON \$0E  
Confg CON \$00  
PDBounce CON \$04  
DBounce CON \$0A  
Peeprom CON \$08  
Reeprom CON \$09  
Pkeyval CON \$0A  
Rkeyval CON \$0B  
Default CON \$11  
Rbuffer CON \$00

' Serial Device Pin Assignments  
Clk CON 14  
Dat CON 15  
CS\_ad1 CON 4  
CS\_ad2 CON 5

' Register Select (1 = char)  
' LCD Enable pin (1 = enabled)

' clear the LCD  
' move cursor to home position  
' move cursor left  
' move cursor right  
' shift displayed chars left  
' shift displayed chars right  
' Display Data RAM control

' Character sent to LCD

' To Master  
' From Master  
' Key press notification pin

' For next loop variable  
' Storage for key values  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte  
' Variable storage byte

' Baud rate = 2400  
' Program configuration command  
' Disable typematic, disable auto  
' Program debounce command  
' Set debounce for 25ms  
' Program user EEPROM command  
' Read user EEPROM command  
' Program key value command  
' Read key value command  
' Resets MEMKey to default values  
' Read key in buffer

' Serial clock control pin  
' Serial data control pin  
' Chip select for A/D one  
' Chip select for A/D two

CS\_pot CON 6 ' Chip select for digital pot.

' Serial Device Variables  
DSpots VAR WORD  
DSpots1 VAR DSpots.lowbyte  
DSpots2 VAR DSpots.highbyte  
Analog1 VAR WORD  
Analog2 VAR WORD  
AD\_in1 VAR BYTE  
AD\_in2 VAR BYTE  
Working VAR WORD  
' Storage word for pot values  
' Voltage control pot for V1  
' Voltage control pot for V2  
' Analog working register  
' Analog working register  
' Results from A/D read of V1  
' Results from A/D read of V2  
' Working register f

' LED pin assignment  
LED\_control CON 7 ' Out of regulation LED indicator

' This routine initializes the BASIC Stamp, LCD, DS1267-010, and MEMKey.

' Initialize the BS2  
BS2\_ini:  
DirH = %01111111 ' set pins 8-15 direction  
OutH = %00000000 ' clear the pins  
DirL = %11110010 ' set pins 0-7 direction  
OutL = %10110010

' Initialize digital potentiometers  
DSpots = \$FFFF ' Initialize V1 and V2 to 3V each  
GOSUB SetPotValue

' Initialize the LCD (Hitachi HD44780 controller)

LCD\_ini:  
OutC = %0011 ' 8-bit mode  
PULSOUT E, 1  
PAUSE 5  
PULSOUT E, 1  
PULSOUT E, 1  
OutC = %0010 ' 4-bit mode  
PULSOUT E, 1  
Char = 40 ' Set for 2 line operation  
GOSUB LCDcmd  
Char = 12 ' Shift cursor right  
GOSUB LCDcmd  
Char = 6 ' Increment DDRAM after write  
GOSUB LCDcmd  
Char = 1 ' Clear LCD screen  
GOSUB LCDcmd

' Initialize the MEMKey  
MEMKey\_ini:  
HIGH FM ' Make sure FM is high  
PAUSE 2000 ' Let the system power settle  
SEROUT FM,Baud,[PConfg,Confg]  
PAUSE 15 ' Configure MEMKey for Polled Mode  
SEROUT FM,Baud,[PDBounce,DBounce] ' Pause 10ms for EEPROM access  
PAUSE 15 ' Program debounce value  
SEROUT FM,Baud,[Pkeyval,Rkeyval] ' Pause 10ms for EEPROM access  
Reset ' Run this when using a new MEMKey

' Initialize output voltage and display  
GOSUB DisplayLCD ' Recall display  
GOSUB UpdateSupply ' Modify output voltages

\*\*\*\*\*MainProgram:



# STAMP APPLICATIONS

adjusted up or down until a closer match occurs.

If, after several adjustments, the desired value does not match the actual value, then the actual value is loaded into the display and the "out of regulation" LED is lit.

This implementation of a digitally-controlled dual power supply required most of the BS2's RAM and EEPROM program memory to implement. However, the code is far from fine-tuned and could be refined to a great degree.

## In Closing

I'm probably going to have a second go at this power supply circuit. The keypad and digital potentiometer will likely be removed. Instead a four-line LCD, four separate 10 bit A/Ds, and a couple of manual potentiometers will be used. The extra A/Ds would be used for current measurement. Further testing is also required to determine regulation under load. I would also like to locate a higher current inductor to maximize the current source capability of the design. It may be feasible to parallel a couple of the Toko inductors that I'm currently using to reach the 2A capability that the MAX726 can provide.

For those of you in need of a higher current system, Maxim also has the MAX724. This part is identical in functionality to the MAX726, but can handle up to 5A of current.

This was one of those designs that seem to force limitations on me. Or maybe I should say that I forced them on myself by sticking with the DS1267-010 as a means of controlling the output voltage. But with those changes that I mentioned above, I think I can tweak this into a successful and useful electronic design.

Regardless, I learned a little, and didn't blow anything up. **NV**

## RESOURCES

For more information on the BASIC Stamp, contact:

### Parallax, Inc.

3805 Atherton Road, #102  
Rocklin, CA 95765

phone (916) 624-8333

<http://www.parallaxinc.com>

### Scott Edwards Electronics, Inc.

1939 S. Frontage Rd. Ste. F  
Sierra Vista, AZ 85635

phone 520-459-4802

fax 520-459-0623

[www.seetron.com](http://www.seetron.com) [info@seetron.com](mailto:info@seetron.com)

### Solutions Cubed

Lon Glazner  
3029 Esplanade Suite F  
Chico, CA 95973

E-Mail: [lon@solutions-cubed.com](mailto:lon@solutions-cubed.com)

[www.solutions-cubed.com](http://www.solutions-cubed.com)

Phone: 530-891-8045

Fax: 530-891-1643

**L**on Glazner is a partner and engineer at Solutions Cubed. Solutions Cubed is an innovative group of design engineers who specialize in embedded control design. They also produce a line of BASIC Stamp compatible products called Miniature Engineering Modules.

## Look Ma, No BASIC Stamp\*

### PicBasic Compiler - \$99.95

Put BASIC Stamp I programs right into a PIC microcontroller - no BS1 module necessary! The programs run faster and can be longer. You also get more variables and extra instructions. For mid-range PIC12C67x, 16C55x, 6xx, 7xx, 8x, 9xx.

### PicBasic Pro Compiler - \$249.95

PicBasic Pro is BASIC Stamp II compatible, and like the standard compiler above, eliminates the need for a BS2 module. Pro adds built-in LCD support, interrupts in BASIC, arrays, program size to 8K, real If..Then..Else and I/O to any PIC pin. For mid-range PIC12C67x, 16C55x, 6xx, 7xx, 8x, 9xx.

\*BASIC Stamp is a trademark of Parallax Inc.

### EPIC Plus PIC Programmer - \$59.95



Programs PIC12C50x, 67x, 16C55x, 6xx, 7xx, 8x, 9xx. Optional ZIF adapters for DIP, SOIC, MQFP, PLCC. Runs off two 9-volt batts

or optional AC adapter. Includes programming software and assembler.

### PICProto Prototyping Boards

Get it wired quicker! High-quality blank prototyping boards for PICmicros. Holds 5V reg, caps, osc, DB9-25, large proto area. \$8.95 - \$17.95



### microEngineering Labs, Inc.

Box 7532 Colorado Springs CO 80933  
(719) 520-5323 (719) 520-1867 fax

<http://www.melabs.com>

email: [info@melabs.com](mailto:info@melabs.com)

Write in 105 on Reader Service Card.

```

IF IN2 <> 1 Then MainProgram
GOSUB KeyFind
GOSUB ModeSelect
GOSUB UpdateSupply
GOTO MainProgram

*****
[ Subroutines ]
*****
LCD commands, such as address pointer, are sent via LCDcmd, characters are sent with the
LCDwr routine. This routine and LCD initialization routines taken from a previous
author's Stamp Applications code listing. I believe it was Jon Williams who wrote the original
code.

LCDcmd:
  LOW RS
  ' Enter command mode
  ' then write the character

LCDwr:
  OutC = Char.HIGHNIB
  PULSOUT E, 1
  OutC = Char.LOWNIB
  PULSOUT E, 1
  HIGH RS
  RETURN
  ' Output high nibble
  ' Strobe the Enable line
  ' Output low nibble
  ' Return to character mode

*****
All display data including voltage levels is stored in the MEMKey's EEPROM
in locations $00-$0F. Whenever the display is updated each character is
read from EEPROM and then sent to the LCD. The leading zeros for the voltage
levels one both line one and line two are displayed as ASCII " " (space). This
makes the display look a little nicer. If this display update routine is too
slow for your design you can just update the voltage levels.

DisplayLCD:
Line1:
  Char = $80
  GOSUB LCDcmd
  For Index = $00 to $07
    SEROUT FM,Baud,[Reeprom,Index]
    ' Read EEPROM command
    ' Display value is read
    ' Translate ASCII tens value into decimal

  SERIN TM,Baud,[B_1]
  If Index <> $04 then TestAn1A
  Analog1 = (B_1 - 48) * 100

TestAn1A:
  If Index <> $05 then TestAn1B
  Analog1 = Analog1 + (B_1 - 48) * 10
  ' Translate ASCII ones value into decimal

TestAn1B:
  If Index <> $07 then TestAn1C
  Analog1 = Analog1 + (B_1 - 48)
  ' Translate ASCII tenths value into decimal

TestAn1C:
  Char = B_1
  If Index <> $04 then Continue1
  If Char <> $30 then Continue1
  Char = " "
  ' Test for leading zero
  ' If ASCII zero then
  ' replace with blank space

Continue1:
  Next
  GOSUB LCDwr

Line2:
  Char = $C0
  GOSUB LCDcmd
  For Index = $08 to $0F
    SEROUT FM,Baud,[Reeprom,Index]
    ' Read EEPROM command
    ' Display value is read
    ' Translate ASCII tens value into decimal

  SERIN TM,Baud,[B_1]
  If Index <> $0C then TestAn2A
  Analog2 = (B_1 - 48) * 100
  ' Translate ASCII tens value into decimal
  
```

```

TestAn2A:
  If Index <> $0D then TestAn2B
  Analog2 = Analog2 + (B_1 - 48) * 10
  ' Translate ASCII ones value into decimal

TestAn2B:
  If Index <> $0F then TestAn2C
  Analog2 = Analog2 + (B_1 - 48)
  ' Translate ASCII tenths value into decimal

TestAn2C:
  If Index <> $0C then Continue2
  If Char <> $30 then Continue2
  Char = " "
  ' Test for leading zero
  ' If ASCII zero then
  ' replace with blank space

Continue2:
  GOSUB LCDwr
  Next
  Analog1 = Analog1 * 256 / 200
  Analog2 = Analog2 * 256 / 200
  RETURN
  ' Analog1 is the desired AD_in1 value
  ' Analog2 is the desired AD_in2 value

***** The Reset subroutine
returns the MEMKey to its initial settings. It also
resets the LCD display values. Upon initial power up of this design
a "GOSUB Reset" should be placed prior to entering the MainProgram code space.
After the EEPROM has been initialized the "GOSUB Reset" may be commented
out or deleted. By doing this the last values displayed, prior to a power down,
will be the values loaded on power up.

Reset:
  SEROUT FM,Baud,[Default]
  PAUSE 200
  SEROUT FM,Baud,[PConfig,Config]
  PAUSE 15
  SEROUT FM,Baud,[PDBounce,DBounce]
  PAUSE 15
  ' Reset MEMKey to default settings
  ' Configure MEMKey for Polled Mode
  ' Pause 10ms for EEPROM access
  ' Program debounce value
  ' Pause 10ms for EEPROM access

  For Index = $00 to $0F
    LOOKUP Index,[ $00,$01,$02,$03,$04,$05,$06,$07,$08,$09,$0A,$0B,$0C,$0D,$0E,$0F],B_1
    LOOKUP Index,[ "1","2","3","4","5","6","7","8","9","C","*","*","D"],B_2
    LOOKUP Index,[ "V","I","*","0","5","0","V","2","0","0","5","0"],B_3
    SEROUT FM,Baud,[Peeprom,B_1,B_3]
    PAUSE 15
    SEROUT FM,Baud,[Pkeyval,B_1,B_2]
    PAUSE 15

  Next
  RETURN

*****
ModeSelect determines which voltage is being adjusted, or if a reset command has been
implemented. The scroll-up and scroll-down modes have not yet been implemented. The scroll ' functions can be
defined once the voltage control method has been proved in the lab.

ModeSelect:
  If KeyVal = "A" then AdjustV1
  If KeyVal = "B" then AdjustV2
  If KeyVal = "D" then ResetSupply
  RETURN
  ' Adjust voltage one has been selected
  ' Adjust voltage two has been selected
  ' A reset command has been entered
  ' Any key other than A,B, or D was pressed and can be

Ignored
AdjustV1:
  SEROUT FM,Baud,[Peeprom,$03," "]
  PAUSE 15
  GOSUB DisplayLCD
  B_2 = $04
  ' Load a " " into EEPROM
  ' Display the " " next to voltage being adjusted
  ' Start EEPROM address at voltage values

AdjV1Continue:
  GOSUB KeyFind
  If KeyVal = "C" then AdjV1Done
  If KeyVal > "9" then AdjV1Over
  If KeyVal = "*" then AdjV1Over
  If KeyVal = " " then AdjV1Over
  SEROUT FM,Baud,[Peeprom,B_2,KeyVal]
  ' Store numeric 0-9 in current EEPROM address
  
```

continued on page 90



```

PAUSE 15
GOTO AdjV1Again
AdjV1Over:
  SEROUT FM,Baud,[Peeprom,B_2,"0"]
  PAUSE 15
  ' If keypress was "A","B", or "D" return a "0"
AdjV1Again:
  GOSUB DisplayLCD
  B_2 = B_2 + 1
  If B_2 = $06 then AdjV1Again
  If B_2 = $08 then AdjV1Continue
  GOTO AdjV1Continue
AdjV1Done:
  GOSUB Limits
  RETURN
  ' Make sure values are within limits
AdjustV2:
  SEROUT FM,Baud,[Peeprom,$0B,">"]
  PAUSE 15
  GOSUB DisplayLCD
  B_2 = $0C
  ' Comments for second line are the same except all
  ' EEPROM pointers are 8 greater than line 1
AdjV2Continue:
  GOSUB KeyFind
  If KeyVal = "C" then AdjV2Done
  If KeyVal > "9" then AdjV2Over
  If KeyVal = "*" then AdjV2Over
  If KeyVal = "+" then AdjV2Over
  SEROUT FM,Baud,[Peeprom,B_2,KeyVal]
  PAUSE 15
  GOTO AdjV2Again
AdjV2Over:
  SEROUT FM,Baud,[Peeprom,B_2,"0"]
  PAUSE 15
AdjV2Again:
  GOSUB DisplayLCD
  B_2 = B_2 + 1
  If B_2 = $0E then AdjV2Again
  If B_2 = $10 then AdjV2Continue
  GOTO AdjV2Continue
AdjV2Done:
  GOSUB Limits
  RETURN
ResetSupply:
  GOSUB Reset
  GOSUB DisplayLCD
  RETURN
  ' Implement reset command
  ' Update display
*****
' Keyfind looks for a logic high on the KEY pin (IN2). If one is present then the Read Key Buffer command
' for the MEMKey is implemented. There is enough RAM allotted in the SERIN command to read a maximum
' buffer size of 8 bytes. It is likely that only one key value will be returned since the typematic rate
' has been turned off in the MEMKey. The SERIN "escape clause" has been set to 50ms to ensure that
' the serial communication does not hang up the program. Once this subroutine is entered it will not
' exit until a key has been pressed. When it does exit the key value will be loaded into the KeyVal
' variable.
KeyFind:
  If IN2 < 1 Then KeyFind
  SEROUT FM,Baud,[Rbuffer]
  SERIN
  ' Check the KEY pin for a logic high
  ' Read buffer command
TM,Baud,50,DoneBuffer,[KeyVal,B_3,B_4,B_5,B_6,B_7,B_8,B_9]
DoneBuffer:
  SEROUT FM,Baud,[Rbuffer]
  PAUSE 40
  If IN2 < 0 then DoneBuffer
  RETURN
  ' If there is a fast key press don't accept it
  ' Wait for KEY pin to go to logic low
*****
' The Limits subroutine checks entered values for out of range or mis-keyed entries. If either
' voltage input is greater than 10.0 or less than 0.0 then the values are forced to either the
' minimum or maximum values accepted. Prior to this routine being exited the ">" character
' that was loaded next to the adjusted voltage is replaced with a space character.
Limits:
  SEROUT FM,Baud,[Peeprom,$04]
  SERIN TM,Baud,[B_1]
  If B_1 > "0" then ZeroOnesV1
  If B_1 = "0" then TestOnesV1
  GOTO NextLimit
  ' Read tens character of voltage on line 1
  ' Check to see if tens is greater than "1"
  ' Check to see if tens is a zero
ZeroOnesV1:
  SEROUT FM,Baud,[Peeprom,$04,"1"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$05,"0"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$07,"0"]
  PAUSE 15
  GOTO NextLimit
  ' If tens is greater than "1" then force display
  ' to "10.0". The "." is not adjusted
TestOnesV1:
  SEROUT FM,Baud,[Peeprom,$05]
  SERIN TM,Baud,[B_1]
  If B_1 > "2" then NextLimit
  SEROUT FM,Baud,[Peeprom,$05,"3"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$07,"0"]
  PAUSE 15
  ' If tens is "0" the read ones character
  ' Check to see if ones is less than "3"
  ' If so then force display to "03.0"
NextLimit:
  SEROUT FM,Baud,[Peeprom,$0C]
  SERIN TM,Baud,[B_1]
  If B_1 > "0" then ZeroOnesV2
  If B_1 = "0" then TestOnesV2
  GOTO DoneLimit
  ' Test voltage on line 2 as line one was tested
ZeroOnesV2:
  SEROUT FM,Baud,[Peeprom,$0C,"1"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$0D,"0"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$0F,"0"]
  PAUSE 15
  GOTO DoneLimit
  ' If tens is "0" the read ones character
  ' Check to see if ones is less than "3"
  ' If so then force display to "03.0"
TestOnesV2:
  SEROUT FM,Baud,[Peeprom,$0D]
  SERIN TM,Baud,[B_1]
  If B_1 > "2" then DoneLimit
  SEROUT FM,Baud,[Peeprom,$0D,"3"]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$0F,"0"]
  PAUSE 15
  ' Test voltage on line 2 as line one was tested
DoneLimit:
  SEROUT FM,Baud,[Peeprom,$03," "]
  PAUSE 15
  SEROUT FM,Baud,[Peeprom,$0B," "]
  PAUSE 15
  GOSUB DisplayLCD
  RETURN
  ' Replace either ">" with a " " (space)
*****
UpdateSupply routine uses the Analog1 and Analog2 values to approximate the
' appropriate digital potentiometer settings. Once the potentiometer is adjusted a For
' Next loop is used to trim the output voltages. If the desired A/D measurement
' stored in the Analog register matches the actual A/D reading in the AD_in
' register the no adjustments to the digital pot are made. Otherwise the
' potentiometer setting is incremented or decremented to trim the voltage until
' the A/D reading is in line with the desired value.
' Trimming is attempted 10 times, with 50ms allotted for settling time between
' adjustments. I found that this system lacked resolution at voltages above about
' 8.5V. For this reason if the digital pot setting is less than 20 I settle for
' an A/D match within 2 bits of the desired value (± 160mV). If, after trimming
' is attempted, the desired A/D value is not reached then the program jumps to
' an out of regulation section. This portion of the code updates the display
' to the actual voltage output, and lights the "out of regulation" LED to
' inform the user that the output voltage has been adjusted.
UpdateSupply:
  LOW LED_control
  DSpots1 = (2376/(Analog1 - 28)) - 14
  DSpots2 = (2304/(Analog2 - 28)) - 14
  GOSUB SetPotValue
  ' Equation to estimate the desired pot setting(V1)
  ' Equation to estimate the desired pot setting(V2)
  ' Update pot settings
TrimV1:
  For Index = 1 to 10
    GOSUB ReadAnalog
    If AD_in1 = Analog1 then DoneV1
    If Index < 8 then NoMinV1
    If DSpots1 > 20 then NoMinV1
    If AD_in1 = (Analog1+2) then DoneV1
    If AD_in1 = (Analog1-2) then DoneV1
    ' Trim voltage 10 times
    ' If on first 7 trims then adj. by 1s
    ' If pot setting > 20 then adj. by 1s
    ' Otherwise accept +/- 2 bits as accurate
NoMinV1:
  If AD_in1 > Analog1 then IncDSpots1
  DSpots1 = DSpots1 - 1
  GOTO DoneV1
  ' Reduce output voltage
IncDSpots1:
  DSpots1 = DSpots1 + 1
  ' Increase output voltage
DoneV1:
  If AD_in2 = Analog2 then DoneV2
  If Index < 8 then NoMinV2
  If DSpots2 > 20 then NoMinV2
  If AD_in2 = (Analog2+2) then DoneV2
  If AD_in2 = (Analog2-2) then DoneV2
  ' V2 follows same adjustment rules as V1
NoMinV2:
  If AD_in2 > Analog2 then IncDSpots2
  DSpots2 = DSpots2 - 1
  GOTO DoneV2
  ' Reduce output voltage
IncDSpots2:
  DSpots2 = DSpots2 + 1
  ' Increase output voltage
DoneV2:
  GOSUB SetPotValue
  Pause 50
  ' Update pot settings after trimming
  ' Allow 50ms for voltages to settle
  ' Trim up to 10 times
NEXT
  GOSUB ReadAnalog
  Working = Analog1 - AD_in1
  If Working < 3 then TestOutOfReg2
  If Working = -Working
  If Working < 3 then TestOutOfReg2
  GOTO OutOfReg1
  ' Read in analog voltages
  ' Find the differences between desired
  ' and actual A/D readings
  ' If < 3 then all OK
  ' If > 3 see if AD_in was > Analog by complimenting
  ' If compliment < 3 then all OK
  ' Not OK so out of regulation
TestOutOfReg2:
  If AD_in2 = Analog2 then DoneOOR2
  Working = Analog2 - AD_in2
  If Working < 2 then DoneOOR2
  Working = -Working
  If Working < 2 then DoneOOR2
  GOTO OutOfReg2
  ' Test analog and AD_in2 for settings
DoneOOR2:
  GOSUB DisplayLCD
  RETURN
  ' Update display values
OutOfReg1:
  HIGH LED_control
  If AD_in1 < 129 then NoChangeAD_in1
  AD_in1 = 128
  ' Light out of range LED
  ' Make sure A/D is under 10V
NoChangeAD_in1:
  Working = (AD_in1 * 200) / 256
  B_1 = (Working / 100) + 48
  SEROUT FM,Baud,[Peeprom,$04,B_1]
  PAUSE 15
  B_2 = (Working / 10)
  If B_2 < 10 then SkipSub1
  B_2 = B_2 - 10
  ' Translate actual A/D value to ASCII
  ' Calculate ASCII hundreds digit from AD meas.
  ' Program MEMKey EEPROM with new value
SkipSub1:
  B_2 = B_2 + 48
  SEROUT FM,Baud,[Peeprom,$05,B_2]
  PAUSE 15
  If Working < 100 then SkipSub2
  Working = Working - 100
  ' Calculate ASCII tens digit from AD meas.
SkipSub2:
  B_3 = (Working - ((Working/10)*10)) + 48
  SEROUT FM,Baud,[Peeprom,$07,B_3]
  PAUSE 15
  GOTO TestOutOfReg2
  ' Program MEMKey EEPROM with new value
OutOfReg2:
  If AD_in2 < 129 then NoChangeAD_in2
  AD_in2 = 128
  ' Update V2 as V1 was updated
NoChangeAD_in2:
  Working = (AD_in2 * 200) / 256
  B_1 = (Working / 100) + 48
  SEROUT FM,Baud,[Peeprom,$0C,B_1]
  PAUSE 15
  B_2 = (Working / 10)
  If B_2 < 10 then SkipSub3
  B_2 = B_2 - 10
  ' Calculate ASCII tens digit from AD meas.
SkipSub3:
  B_2 = B_2 + 48
  SEROUT FM,Baud,[Peeprom,$0D,B_2]
  PAUSE 15
  If Working < 100 then SkipSub4
  Working = Working - 100
  ' Calculate ASCII ones digit from AD meas.
SkipSub4:
  B_3 = (Working - ((Working/10)*10)) + 48
  SEROUT FM,Baud,[Peeprom,$0F,B_3]
  PAUSE 15
  GOTO DoneOOR2
  ' Program MEMKey EEPROM with new value
*****
' The SetPotValue shifts the pots settings out to the DS1267-010.
SetPotValue:
  HIGH CS_Pot
  PULSOUT Clk,10
  SHIFTOUT Dat,Clk,msbfirst,[DSpots\16]
  LOW CS_Pot
  PAUSE 10
  RETURN
  ' The ReadAnalog routine reads in the actual output voltages from the ADC0831 8 bit A/Ds.
ReadAnalog:
  LOW CS_ad1
  SHIFTOUT Dat,Clk,2,[AD_in1\9]
  HIGH CS_ad1
  LOW CS_ad2
  SHIFTOUT Dat,Clk,2,[AD_in2\9]
  HIGH CS_ad2
  RETURN
*****
END:

```



# Making RS-232 Interfaces Work

by Gerald Roylance

**T**he RS-232 interface is one of the most common ways of getting information into and out of a computer. Although originally intended for connecting a modem to a computer, the interface has been widely used for connecting devices such as test equipment, weather stations, PROM programmers, and signal digitizers. Sadly, many of these devices disobey the RS-232 standard, and that causes headaches and hung computers. Misunderstandings about the RS-232 interface have buried us in a profusion of swapped pins, gender changers, breakout boxes, and hydra-headed cables.

RS-232 is a well thought out standard for interfacing computers (or terminals) to modems. Remembering that RS-232 is about connecting computers to modems is the first step in understanding RS-232. **RS-232 was never intended to directly connect a computer to another computer. RS-232 connects a computer to a modem.**

Unfortunately, many of today's RS-232 applications do the unintended. We connect computer-to-computer, computer-to-terminal, computer-to-printer, and computer-to-digital voltmeter using RS-232 interfaces — all without apparent modems. RS-232 did not intend these applica-

**RS-232 was never intended to directly connect a computer to another computer. RS-232 connects a computer to a modem.**

tions, and it is not surprising that confusion reigns.

The secret to understanding RS-232 is recognizing the phantom modems, because the modems have to be there for RS-232 to work.

The modems may be disguised as swapped pins, or a voltmeter may masquerade as a modem. Before delving into the details of RS-232, let's show what an RS-232 user should see in an ideal world.

## The Rational RS-232 World

**M**any RS-232 products are irrational. My local computer store has an aisle full of RS-232 accessories. There are cables of different lengths, different connector combinations, and different wiring. There are gender changers, null modems, and break out boxes. Surprisingly, most of these products are incompatible with RS-232. Although the store sells five different models of null modems, each model violates the RS-232 specifications. If everybody followed the rules, the world would be much simpler.

The connectivity requirements of RS-232 are summarized in three rules, but first we must get two definitions out of the way. The standard refers to computers and terminals as Data Terminal Equipment (DTE), and it refers to modems as Data Communications Equipment (DCE). Here are the connectivity rules.

Rule 0. RS-232 connects Computers and Terminals (DTE) with Modems (DCE).

Rule 1. Computers and Terminals (DTE) must present male connectors.

Rule 2. Modems (DCE) must present female connectors.

For a practical introduction to these rules, look at the back of your computer, and you should see a male RS-232 connector. Figure 1 shows the back of my computer with its RS-232 connectors. If you have an external modem, then it should have a female connector.

These rules must be followed all the time. If you see a male RS-232 connector, then it better

be a DTE interface. If the connector is female, then it better be a DCE interface. The rules still apply after you connect a cable. If you plug an ordinary cable into the male DTE connector on your computer, then the free end of that cable should still present a male (DTE) connector. RS-232 demands that the sex of the connector indicate its use. Figure 2 shows how RS-232 interfaces connect two computers. When you look at the figure, pay attention to the sex of the connectors.

These three rules show that many computer store products violate the RS-232 standard. Gender changers, for example, violate Rule 1 or Rule 2. Consider plugging a female-female gender changer into a DTE connector. The free end of the gender changer presents a female connector, but the internal wiring didn't change (it is still DTE), and that violates Rule 1. Similarly, using a male-male gender changer on a DCE interface violates Rule 2. Any cable whose pins are connected straight through and has the same sex connector on each end is just an extra-long gender changer, so such a cable also violates RS-232.

A null modem simulates the back-to-back connection of two modems (it should be called a null dual modem). Figure 2 shows how a null modem fits into the RS-232 framework. Both sides of the null modem are DCE, so a null modem (or null modem cable) must present two female connectors. A null modem with a male connector violates Rule 2, but my computer store sells several.

What should the computer store sell? If all equipment followed the RS-232 standard, then the only accessories you need are:

1. Null modems with female connectors on each end and the proper wiring (see null modem sidebar).
2. Various RS-232 cables with a male connector on one end and a female connector on the other end. The wiring should be straight through

Model PTS-10  
\$55



**LIFETIME WIRE STRIPPER**, a breakthrough in wire stripping technology. Extremely fast tool will strip PVC insulation #14 to #30 AWG from solid, stranded or shielded wires. High quality strip is achieved by patented stripping element (.008" thick) which thermally cuts the insulation all the way to the conductor without nicks. Five year test, with over 2 million stripped wires, using the same element, speaks for itself. The stripper has won a —

### "FIVE STAR PRODUCT OF THE MONTH"

award in DESIGNFAX magazine. Strippers for TFE, KAPTON, KYNAR, SILICONE RUBBER, etc. and rechargeable, battery powered strippers also available.

**PATCO Service, Inc.**, 2515 Glencoe Rd., Baltimore, MD 21234  
(410) 444-4010 Fax (410) 254-9566

Write in 50 on Reader Service Card.

## USB Relay Module

### Model JSB-210

Controls 8 to 16 "form C" relays over the USB (Universal Serial Bus). Program the module with simple commands in any program language that supports USB Communications. Driver and sample code provided

### J-Works, Inc

12328 Gladstone St., Unit 4  
Sylmar, CA 91342  
(818) 361-0787 Voice (818) 270-2413 Fax

### Other Products

RS-485 Remote I/O  
ISA Waveform Generator  
RS-485 to DS-1820  
RS-485 Temperature I/O  
DS-1820 Probe

Visit our Web site for  
Information on all our products  
<http://www.j-works.com>  
E-mail [sales@j-works.com](mailto:sales@j-works.com)

Write in 29 on Reader Service Card.





**Figure 1.** The back of my computer and its DTE interface. The top bracket has two DTE ports — a male DB25 and a male DB9. The female DB25 is the printer port (which is not RS-232).

(i.e., no twists or "null modem" cables) and should include pins 1-8, 20, and 22. These cables are RS-232 extension cords.

These accessories guarantee correctly connecting RS-232 devices. You can use an extension cord to connect a computer and a modem, but you cannot connect a computer to a computer (or a modem to a modem) because the connectors won't mate. When you try to connect a computer to a computer with an extension cord, you run into the problem of trying to plug a male connector into another male connector. This mismatch tells you to use a null modem. If you can

plug the devices together with the approved accessories, then the connection must be right. Unfortunately, this utopia is destroyed when someone introduces a gender changer or some other incompatible product.

Although a null modem cable with female connectors on both ends obeys the RS-232 rules, you don't need such a cable because it is just an extension cord with a null modem plugged into one end. Extension cords are more useful than null modem cables, so I always buy the extension cords. It's also easier to think about cables being wired straight through. The only time I use null modem cables is when the wiring runs in the

walls of the building, and I want the walls to look like DCE.

In a perfect world, you would never use a gender changer. But the world is imperfect, and I use gender changers to fix RS-232 design errors. When an ignorant manufacturer uses the wrong sex connector, I use a gender changer to fix the device — and I'm tempted to epoxy the gender changer in place.

If you follow the rules, then your RS-232 connections should be painless. Now let's look at the details of the standard.

## The RS-232 Standard

The standard includes a set of signals, which is described next. After that description, we show how a typical interface operates.

### RS-232 Signals

Table 1 lists the RS-232 signals and pin assignments. Although there are many defined signals, only three pins (SG, TXD, and RXD) actually send data back and forth. Devices that use only these three pins should be called serial interfaces. An RS-232 interface requires the first seven signals in the table, and a practical RS-232 interface should include DTR and DCD. Many interfaces also include RI, and the other signals are rare.

There are four interface signal classes: grounds, data signals, control signals, and clock signals. Each signal has a standard signal designation (e.g., BA), a description (e.g., transmitted data), and a common signal designation based on the description (e.g., TXD). The CCITT uses numbers for its standard designation (e.g., EIA's BA is CCITT's 103), and some of those numbers are given. The RS-232 standard specifies a 25-pin connector, but it did not assign all the pin numbers. The IBM PC adopted a nine-pin connector, and its pin assignments are also in the table.

### Signal Levels

The RS-232 standard uses bipolar signal levels. The signal characteristics are loose, but the pin voltage should be 5 to 25 volts for a positive voltage level and -5 to -25 volts for a negative voltage. These voltage levels are interpreted differently for data signals and control signals.

For data signals, the negative voltage represents a binary 1 (also called a mark or a marking level), and the positive voltage represents a binary 0 (also called a space). An idle line (no data being

## 68HC11 & 68HC12 Modules for Solderless Breadboards & Embedded Applications

- miniature interchangeable modules, from 1.7" by 2.6" small
- versatile connector options, including 'DIP-style' spacing, for use with solderless breadboard—great for educational use!
- all modules have reset circuit, pushbutton, & Load/Run switch
- RS-232 interface & 5V regulator are standard on all modules
- all I/O signals brought out to standardized connector pinout

One-piece price from \$63, depending on configuration...

68HC11 Starter Package comes with Adapt11 module for solderless breadboard, 68HC811E2 microcontroller with 2K EEPROM on-chip, PC serial cable for downloading code, Motorola Programming Reference Guide, Adapt11 Handbook, programming & downloading utilities, & demo program. (#AD11SP) \$74.95 + \$5 S&H. Students: ask for 15% discount.

**EXPANSION ACCESSORIES:**

- Backplanes, prototyping cards, applications cards, and memory expansion

Plug PLCCs, D-sub connectors, ribbon cables, and 1mm flex cables right into your Solderless Breadboard with our complete range of low-cost adapters!

### NEW PRODUCT!

#### ADAPT-812DX

- 68HC812A4 expanded SBC
  - 128K or 512K Flash
  - 128K or 512K SRAM
  - Real-time clock/calendar
  - modular & stackable
  - RS232 & RS485 interfaces
  - 3.25" x 3.25" quality pcb
- Starter Packages:
- |               |       |
|---------------|-------|
| AD812DX128-SP | \$189 |
| AD812DX512-SP | \$229 |

Terms: Credit Cards, Check, Money Order, School & Government P.O.s accepted. All prices in US dollars.

## TECHNOLOGICAL ARTS

26 Scollard St., Toronto, Ontario, Canada M5R 1E9  
Phone: (416) 963-8996 • Fax: (416) 963-9179  
techart@interlog.com • www.interlog.com/~techart

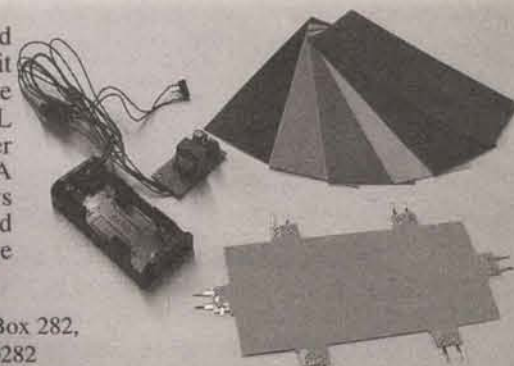
## LIGHT WORKS USA™

By Miller Engineering

### Electroluminescence Experimenters Kit!

\$22.95 plus \$3.00 S&H

This exciting kit is designed just for the experimenter! Kit includes one 1.7"x 3.75" white EL lamp that makes up to 6 EL lamps. Ready to run power supply that runs on two AAA batteries. Six color overlays and complete instructions and ideas on using this space age marvel.



Send To: Miller Engineering, P.O. Box 282, New Canaan, CT 06840-0282

Tel. 203-595-0619 Visa & Mastercard accepted. Personal checks must clear first. www.microstru.com



transferred) is held in the marking state (binary 1).

For control signals, a positive voltage represents ON, and a negative voltage represents OFF. The standard further requires that RTS, DTR, and DSR be fail-safe signals. These signals are interpreted as OFF even when half of the interface is powered down. This requirement has several benefits, such as turning off your computer turns DTR OFF, which tells your modem to hang up the phone, which saves long distance charges.

## Grounds

**Circuit AA.** Protective Ground (FG). This circuit is the chassis ground (the green lead on the power supply connector).

**Circuit AB.** Signal Ground (SG). All the data and control lines share the signal ground wire.

## Data

**Circuit BA.** Transmitted Data (TXD). The DTE should supply data only when CTS is ON.

**Circuit BB.** Received Data (RXD).

## Control

**Circuit CA.** Request To Send (RTS). The DTE asserts RTS when it has something to transmit. When the DCE receives RTS, it should turn on its transmitter or modulator. In half-duplex operation, this signal determines whether the DCE is receiving or transmitting. In receive-only applications, RTS must be held OFF.

**Circuit CB.** Clear To Send (CTS). The DCE responds to RTS by asserting CTS when the communications channel is ready to transmit. When RTS goes OFF, CTS must also go OFF.

**Circuit CC.** Data Set Ready (DSR). DSR says the DCE is ready to operate. The signal is OFF when the data set is disabled or impaired. If the telephone is on hook, then DSR is OFF. DSR describes the local status of the DCE and does not imply connection to another modem.

**Circuit CD.** Data Terminal Ready (DTR). DTR ON tells the DCE to connect to the communications channel (go off hook). DTR OFF means disconnect the DCE from the communications channel (go on hook).

**Circuit CE.** Ring Indicator (RI). RI ON says the phone is ringing, and RI is asserted even if DTR is OFF.

**Circuit CF.** Data Carrier Detector (DCD). DCD indicates reception of a data carrier. OFF indicates the end of transmission or an error (e.g., a weak carrier signal).

Many control signals have been superseded by other methods. The speed controls, for example, worked fine for a two-speed modem, but

# ELECTRONIX EXPRESS

## WELLER SOLDERING STATION - MODEL WLC 100

- Variable power control (5 to 40 watts)
- Replaceable heating element
- Quality light-weight pencil iron

**\$36<sup>95</sup>**

## LOWEST PRICE 20MHZ SCOPE!

**INSTEK<sup>®</sup>**  
**OSCILLOSCOPE**  
20MHZ  
DUAL CHANNEL  
MODEL GOS-620

**\$299<sup>00</sup>**

**SCOPE PROBE 60 MHZ**  
SWITCHABLE X1, X10

**\$12<sup>95</sup>**

## DIGITAL MULTIMETER

WITH CAP/FREQUENCY  
TRANSISTOR TESTER  
Model DM645

**\$34<sup>95</sup>**

## PAD-234 DIGITAL/ANALOG TRAINER

Complete portable workstation. Variable and fixed power supplies, function generator, digital I/O, rugged design, high impact case.

Assembled

**\$150<sup>00</sup>**

Kit

**\$110<sup>00</sup>**

## INSTEK FUNCTION GEN.

WITH INT/EXT  
FREQ. COUNTER  
MODEL 8016

**\$199<sup>00</sup>**

## ALLIGATOR LEADS

SET OF 10

**\$2<sup>10</sup>**

## SWITCHES

8 POS DIP

60¢ ea.

Mini Toggle SPDT

50¢ ea.

## HIGH QUALITY TOOLS

With Cushion Grips and Return Spring

Needle Nose Pliers

**\$2<sup>95</sup>**

Wire Stripper

**\$1<sup>50</sup>**

Diagonal Cutter

**\$2<sup>95</sup>**

## POWER SUPPLIES

0-30 VDC, 0-3 Amp. Built-in current limiting, overload protected, constant voltage and current operation.

01PSGP4303A Analog Display

**\$165<sup>00</sup>**

01PSGP4303D Digital Display

**\$189<sup>00</sup>**

## RSR TELECOMMUNICATIONS TRAINER

HANDS-ON TELEPHONY, LAN, CATV EXPERIENCE

WITH ONE SELF-CONTAINED UNIT

T-Comm Trainer (TCM-100)

Lab Manual / Work Book

Component and Supplies Kit

Tool Kit

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**Only**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**Only**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$199<sup>95</sup>**

**\$19**



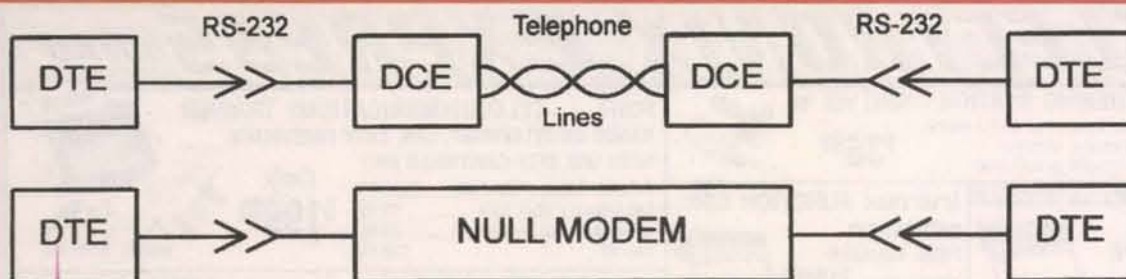


Figure 2. Diagrams of conventional RS-232 connections.

25 Pin	[9 Pin]	Circuit	Source	Common	Description
1†		AA 101	-	FG	Protective Ground
7†	5	AB 102	-	SG	Signal Ground
2†	3	BA 103	DTE	TXD	Transmitted Data
3†	2	BB 104	DCE	RXD	Received Data
4†	7	CA 105	DTE	RTS	Request To Send
5†	8	CB 106	DCE	CTS	Clear To Send
6†	6	CC 107	DCE	DSR	Data Set Ready
20	4	CD 108	DTE	DTR	Data Terminal Ready
22	9	CE 125	DCE	RI	Ring Indicator
8	1	CF 109	DCE	DCD	Data Carrier Detector
		CG	DCE		Data Modulation Detector
23*		CH	DTE		Speed Selector
12*		CI	DCE		Speed Selector
24		DA	DTE		Trans. Signal Element Timing
15		DB	DCE		Trans. Signal Element Timing
		DC	DTE		Rcvr. Signal Element Timing
17		DD	DCE		Rcvr. Signal Element Timing
21*		RL	DTE	RDL	Remote Digital Loopback
9*		+P	DCE		+12V through 1K resistor
10*		-P	DCE		-12V through 1K resistor

†RS-232 requires that this signal be present.

\*These pin assignments are common, but are not specified in the standard.

RS-232 calls for a 25-pin connector, but many PCs use a DB9 connector.

RS-232 reserves pins 9 and 10 for DCE tests; they must be left open in DTE equipment.

## Table 1. RS-232 Signals

connection, and it is one reason that an answering modem spits out a carrier tone.

When the DCE has transferred its data, it may drop DCD (half-duplex communications) or it may leave DCD asserted for the duration of the connection (full duplex). Most connections can transmit and receive simultaneously (full duplex), but some connections (e.g., packet radio) are half-duplex.

If the DTE side has some data to send, it first asks the DCE for permission by asserting a request to send (RTS). The DCE grants permission by asserting clear to send (CTS), and then the DTE starts sending the data. In a half-duplex environment, the DTE drops RTS when it has no more data to send. In a full duplex environment, the DTE will leave RTS asserted for the duration of the connection. When the DTE is finished with the connection, it will drop DTR, essentially telling the DCE side to hang up the connection. The DCE responds by dropping DSR, and the connection is back to its initial state.

### Implications for Hardware Designers

If your hardware is a modem, then following the standard is pretty clear. An RF modem, for example, would turn the transmitter on when RTS is asserted. If your hardware isn't a modem, then following the standard isn't so obvious. You can make your equipment look like DTE or DCE. Although a DTE interface seems more appropriate if the hardware includes a microcomputer, a DTE interface requires a null modem to connect it to a computer. If the hardware will be directly connected to a computer, the DCE interface is more convenient.

Once you have decided on the type of interface, then you must decide how to supply the RS-232 control signals. Adding the control signals — even if they are just tied high or jumped — makes your project more robust and reduces software problems. If you supply the control signals, then

the computer won't hang because it doesn't see DSR or CTS. Furthermore, the computer can use the RS-232 control lines to determine if the device is connected — no DSR means the device isn't there. After all, that's what the RS-232 signals were intended to do.

If you make your hardware look like DTE, then you should supply two control signals, DTR and RTS. At a minimum, power on should assert DTR (the device is asking for a connection to the communications channel). If the device transmits data, then pull RTS high. If it doesn't transmit data, pull RTS low. If you can, obey the CTS signal from the DCE.

If your hardware looks like DCE, then you must supply DSR, DCD, and CTS. Either jumper DSR to DTR or have power on pull DSR high (better). A clever implementation can power down if DTR is OFF. If the device outputs data, then DCD can follow DSR; if no data is output, then pull DCD low. If the device doesn't take input, pull CTS low; if the device takes input, then at least connect CTS to RTS.

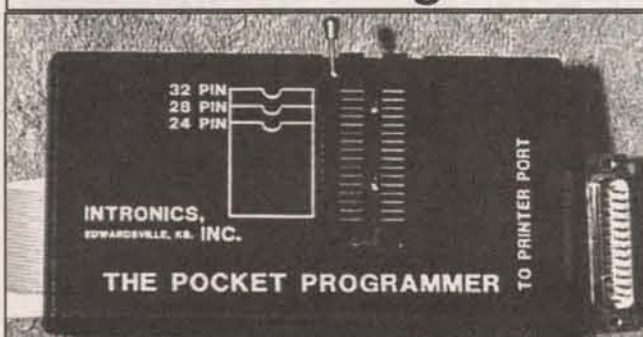
possible.

The initial state is all control signals are off and both sides of the interface are asleep (i.e., not ready). The DTE usually starts things off by asserting data terminal ready (DTR), which tells the DCE to wake up. When the DCE is ready, it asserts DSR. At this point both sides are powered up and ready to exchange other control signals,

but DSR doesn't imply contact with a remote modem. DTR and DSR will stay ON for the duration of the connection. When both sides are ready, then it is possible to transfer data.

If the DCE side has some data to give the computer (DTE), it first asserts data carrier detect (DCD), and then it sends the data over the received data line (RXD). A data carrier indicates a

## The Pocket Programmer



The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs E(E)prom, Flash & Dallas Ram. 27(C)/28(C)/28F/ 29F/29CXXX & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, MCU's 874X, 875X, 40-Pin X 16 & Serial Eprom's, PLCC, 5-Gang, 82/74 Prom's and Eprom Emulator to 32K X 8.

Only \$129.95

Same Name, Address & Phone Number for 16 Years....  
Now isn't that Amazing ?

**Intronics, Inc.**

Box 13723 / 612 Newton St.

Edwardsville, KS 66113

Tel. (913) 422-2094

Fax (913) 441-1623 Visa / Master Charge / Amex

Add \$5.00 COD

Add \$4.00 Shipping

## ATTENTION

### DEALERS/DISTRIBUTORS

#### BUY DIRECT FROM THE MANUFACTURER

THESE AND OTHER VIDEO SECURITY PRODUCTS NOW AVAILABLE!!! (DEALERS/DIST. ONLY) Minimum Order.

	Qty 5	Qty 10	Qty 20	Qty 50+
CCD Cameras				
B&W Board	\$57	\$52	\$47	Call!
B&W Board/sound	\$62	\$57	\$52	Call!
B&W Mini	\$65	\$60	\$55	Call!
Color - Mini	\$150	\$142	\$135	Call!

\*B&W CCDs use Sansome Chips. Color CCDs use Sony.

Guardian Eye

#### CCD Camera Hidden Inside a "Magnavox" Clock

	Qty 5	Qty 10	Qty 20	Qty 50+
CCD Clock				
B&W Wired	\$144	\$129	\$114	Call!
B&W Wireless	\$289	\$264	\$248	Call!
Color Wired	\$234	\$218	\$199	Call!
Color Wireless	\$387	\$362	\$345	Call!

Wireless use 2.4Ghz standard transmitters and receivers.

#### Call ATN Today for the Best Prices and Quality Security Products.

American Technologies Network Corp.

20 S. Linden Ave. #1B

S. San Francisco, CA 94080

www.atncorp.com

1(800)910-2862

1(650)875-0130

fax: 1(650)875-0129

sales@atncorp.com



I favor the DCE wiring for devices that connect directly to a computer (such as a scale or voltmeter). Even quick and dirty projects can meet the RS-232 signaling convention with two jumpers. The first jumper connects DTR to DSR and DCD. The second jumper connects RTS to CTS.

## Programming the Interface

Not only must the hardware be correct, but the software must also work. From a programming standpoint, you are much better off using standard library functions to talk to a serial port rather than programming the hardware directly. Library routines allow the programmer to set the baud rate, data format, and control lines without getting lost in details about specific I/O registers. Sadly, the library calls vary widely among operating systems and programming languages.

In general, the program should supply all the required RS-232 interface signals so an RS-232 device will wake up and respond correctly. If the program fails to assert DTR, then an RS-232 device may not wake up. If the program doesn't assert RTS, then the RS-232 device may ignore everything on TXD. The program must supply these signals to avoid a catatonic connection.

The program should also obey the DCE signals DSR, CTS, and DCD. These signals tell your program that a connection exists and prevent the hardware from being overwhelmed with data. It's easy to make your hardware RS-232 compatible (only two jumpers), so all of your projects can follow this convention.

When your program must talk to existing (non-RS-232) hardware, things get ugly. The best option is to use RS-232 control signals in your program and correct the hardware deficiency with an adapter that does the RS-232 control handshake (see sidebar about adapters). That way, your program can recognize a disconnected device rather than just blasting bits. Alternatively, the program can ignore DSR, CTS, and DCD — but it should still assert DTR and RTS. The penalty for ignoring these control lines is often more involved programming.

## Programming in Basic

I looked for authoritative advice on programming the serial port with Basic, but the only relevant documents I found were some knowledge base articles (Q39342, Q39386, and Q94007) on the Microsoft Developer Network. You can find these articles at <http://msdn.microsoft.com>. The information is sketchy.

The open statement should look something like

```
OPEN "COM1:1200,N,8,1,BIN,CD0,CS0,
DS0,OP0,RS,TB2048,RB2048" AS #1
```

This statement opens the port COM1 at 1200 baud, no parity bit, eight data bits, and one stop bit. Other combinations of parity, data, and stop bits are possible, but make little sense because almost all links are (N,8,1). Trying to guarantee the eighth bit is zero by specifying (N,7,2) is a poor practice (it sets the eighth bit at the other end!); what you want is (S,7,1), but you are bet-

## Helpful Adapters

Special adapters make debugging and fixing troubled RS-232 connections easier.

### RS-232 Line Analyzer

An RS-232 analyzer is the quickest way to see what is going on. Many years ago, these adapters were expensive, but today RadioShack sells its 276-1401 line analyzer for \$15.00, and I bought the analyzer in Figure 3 for \$8.00. The analyzer's two color LEDs display the line state: green for ON and red for OFF. If the signal is not driven, then neither color lights. External modems often display this line status information, and some terminal programs do the same.

The analyzer displays the crucial control signals, and it quickly uncovers problems with the control handshaking. A flickering TXD or RXD indicates data transfer. If you are writing software, use an analyzer to confirm your code.

RS-232 violations are easy to spot, too. If a device presents a female connector (DCE) but lights the TXD LED, then the interface is wrong. Of course, this task would be easier if the LED layout in Figure 3 were better; the DTE-driven LEDs and the DCE-driven LEDs should be in separate groups. The signals DTR, RTS, and TXD should be next to the female connector (bottom connector in photo), and the LEDs for DSR, CTS, RXD, and DCD should adjoin the male connector (top connector).

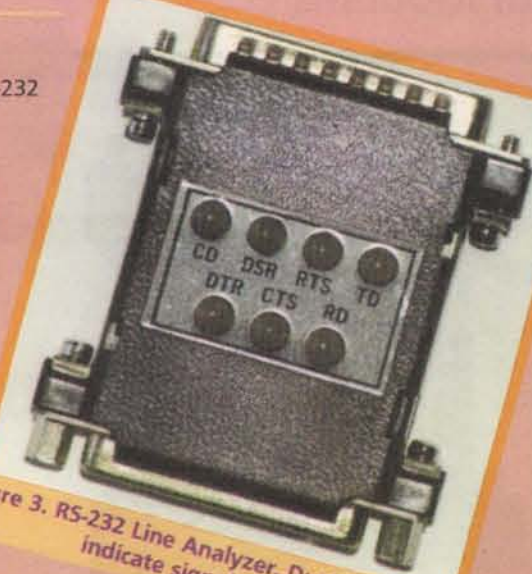


Figure 3. RS-232 Line Analyzer. Dual-color LEDs indicate signal values.

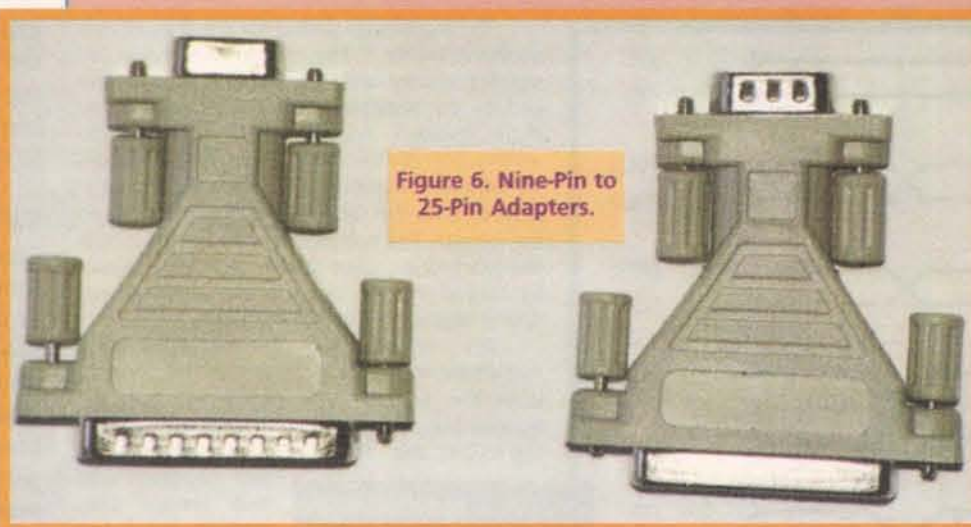


Figure 6. Nine-Pin to 25-Pin Adapters.

### Loopback Adapter

A loopback adapter (Figure 4) quickly tests a COM port and instills confidence in a program. The loopback adapter echoes every character sent. It makes a terminal program behave as a typewriter, and some simple write and read statements will verify your programming ability. The loopback adapter manages all the modem control signals, and it is insensitive to baud rate. If you cannot make a

COM port work with a loopback adapter, then something is seriously wrong.

The loopback adapter is a DCE device, so it has a female connector. DTR returns DSR, and transmitted data is copied to received data. RTS asserts both CTS and DCD.

### Local Control Loopback Adapter

If you have a program that wants the control signals, but the hardware doesn't supply them, then you can use this adapter (Figure 5). It generates the DCE control signals locally but sends the data through. Asserting DTR responds with an immediate DSR and DCD. RTS produces a CTS so the transmit data doesn't hang.

### 9 to 25 pin adapters

RS-232 specifies 25 pin connectors, but IBM PC clones use nine pin connectors to save space. To handle these transitions, you need two adapters: a male nine-pin to a female 25-pin, and a female nine-pin to a male 25-pin connector (see Figure 6).

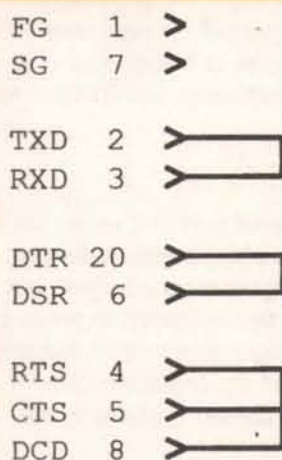


Figure 4. Loopback Adapter.

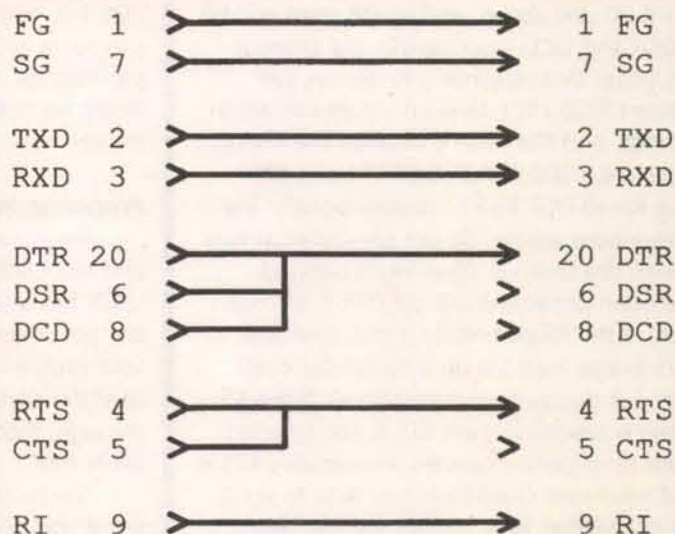


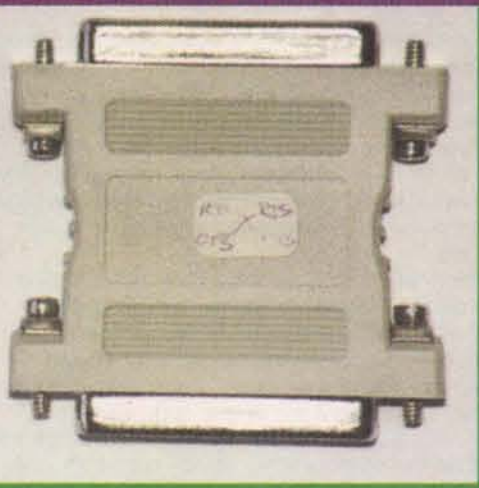
Figure 5. Local Control Loopback Adapter.



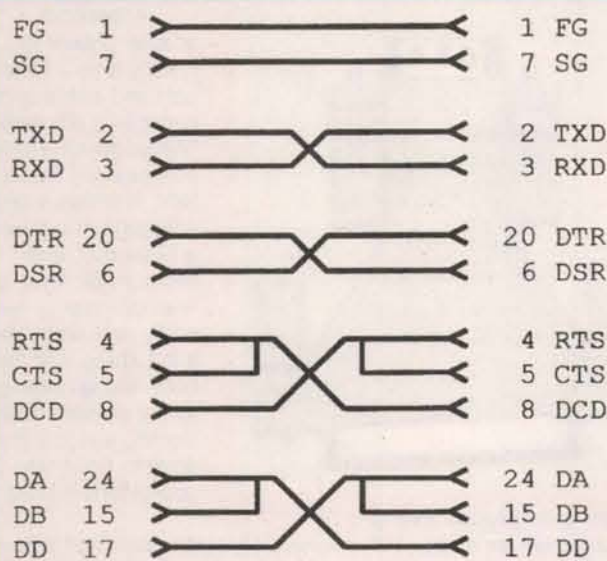
## Null Modems



**Figure 8. Null modems.** The modem on the left has the correct wiring but uses a male connector (notice the dimples on the metal shell of a male connector). The modem on the right has the correct connectors but the wrong wiring.



A null modem must not only have female connectors on both ends, but it must also properly interact with the DTE interfaces, and that determines the internal wiring of the null modem. Commercial null modems offer many different internal wirings, and most are flawed. Some null modems even have asymmetrical wiring, but that defies reason.



The reasonable wiring for a null modem is shown in Figure 7. The grounds are connected straight across, and the transmit and receive circuits are swapped. The control signals are more involved. Asserting DTR on one side asserts DSR on the other. To make half-duplex signals work, asserting RTS produces an immediate CTS on the same side and issues DCD on the far side. The null modem can also distribute the synchronous (but rarely used) clock signals by connecting the DTE's transmitter element timing signal (DA) to DB and DD.

My computer store does not sell a good null modem. Figure 8 shows a null modem with the proper internal wiring, but the adapter has male (DTE) connector that violates the RS-232 specification. Figure 8 also shows a

Figure 3 also shows a null modem with two female connectors, but it has the wrong wiring.

**Figure 7. Standard Null Modem Wiring.**

The wiring is called "Full Handshake," but it misinterprets the RTS control signal.

ter off with (N,8,1) and keeping your application eight-bit clean. To test for parity errors, you must add a "PE" option after the number of stop bits, but very few applications use parity. The BIN parameter is the default, but it makes it clear that you don't want ASC.

The CDM, CSM, DSM, and OPM parameters set the timeouts for DCD, CTS, DSR, and the open statement. The OP timeout is for QuickBasic versions 4.00 and above, and an OP open will fail unless DSR and DCD assert within the timeout interval. (Note that transmit-only devices will never assert DCD.) The timeout values (m) are in milliseconds, and the value 0 disables the check. Consequently, "CD0,CS0,DS0,OP0" turns off checking for all DCE RS-232 control signals. The knowledge base articles do not specify what happens when the timeout value (m) is omitted.

The open command will set DTR if the open succeeds. If the RS parameter is not specified, then RTS is also asserted on a successful open (assumes full duplex communications). If the RS parameter is specified, then RTS is not asserted when the serial port is opened. Presumably RTS is asserted whenever QuickBasic has data to send, but the knowledge base articles are not clear.

The TB and RB commands set the size of the transmit and receive buffers, but these com-

mands are needed only for high-speed communications.

Microsoft describes the above OPEN statement as tolerant because it ignores handshaking. Your code will be better if you use non-zero time-outs for the control signals and check for errors.

To compound the problem of debugging RS-232 code, Microsoft has confirmed bugs in several versions of Basic for MS-DOS (Visual Basic 1.0, PDS 7.1, and QuickBasic 4.5). The bugs cause programs to hang unexpectedly — even after working for several minutes or hours. Your code might be right but still not work. See Q94007 for details.

## Programming in C/C++

Programming the serial port in C under UNIX and Microsoft Windows offers some challenges. UNIX has a sensible programming interface, but the port must be correctly configured to prevent your program and the login demon from fighting over the port. If only half the characters get through, then the login demon is grabbing the other half.

The recommended way of programming the serial port under Windows depends on the version of Windows. If you use `OpenComm()`, then after opening the port you should call

FlushComm() to clear the input and output queues, and then call GetCommError() to enable the hardware. There is a good chance that the hardware saw a framing, overrun, or some other fault, and was disabled. When the hardware is disabled, it doesn't issue any messages to your driver loop, so your program won't see any serial port activity. Procedures such as OpenComm(), SetCommState(), and SetCommMask() don't return errors if the port is disabled; your program must issue a GetCommError() at initialization.

## More Complications — Flow Control

Ideally, a modem can take data as fast as the computer can dish it out, and vice versa. This is not true in practice. Initially, computers transferred a character at a time, and it was possible that the computer might be distracted long enough to lose a character. These problems got worse as the data rate went higher and the interrupt loads were heavier. FIFO buffers help, but they can never be deep enough. Modems are complicated, and the data rates on the RS-232 side don't match the data rates on the communication channel. Without flow control, one side or the other will run out of buffer space. To avoid overflowing its buffers, the modem must tell the computer when to stop sending data and when to resume. There are two common methods.

The first method uses control characters in the data stream. The common characters are Control-S and Control-Q. When the transmitter is running out of buffer space, it sends a Control-S to shut the computer up. When enough buffer space is free, a Control-Q tells the computer to resume. Although this method is popular, it has drawbacks. The main problem is Control-S and Control-Q are in-band characters (they could be part of a binary data stream). If data is being transmitted both directions at the same time, we must quote data characters that would be interpreted as flow control characters. Some applications, such as fax modems, can skirt this problem because binary data flows only one way at a time. Consequently, one direction is used for binary data, and the reverse direction is used for Control-S and Control-Q.

The second method is hardware flow control. This method uses out-of-band signaling, so binary data can flow both ways at the same time. Unfortunately, hardware flow control bends the RS-232 rules. A modem can tell the computer to stop sending characters by making CTS go away. Notice that CTS may go away in the middle of transmitting a character; something that RS-232 didn't expect. In fact, several more characters may get transmitted (e.g., the rest of the FIFO) before transmission stops. The receiving end must issue the flow control command well before it actually runs out of buffer (the same is true for software flow control). DSR can also be used for hardware flow control, but CTS is better.

Hardware flow control for data going to the DTE is a harder problem because RS-232 does not have a "Clear To Receive" signal. One method is to toggle DTR, but then the modem must realize that DTR OFF does not mean hang up the phone. Fortunately, a computer can use large buffers and take data faster than a modem can supply it, so flow control in this direction is avoidable. If flow control is required, software flow control (Control-S and Control-Q) will work. **NV**



# New Product News

## UNI-MICRO BOARD

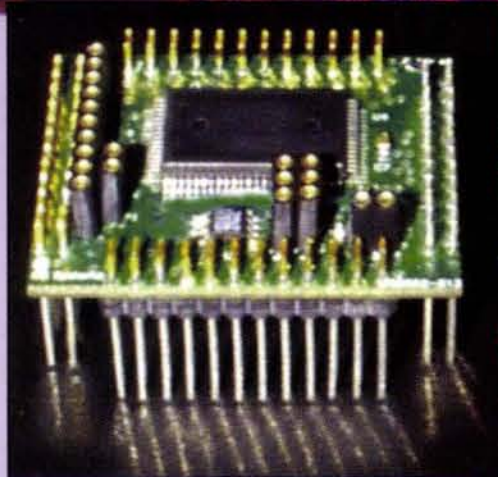
**O**S Systems announces the availability of a new, compact 8051 compatible embedded controller module.

The Uni-Micro board features a combination of memory, digital, and analog I/O that is perfect for instrumentation, monitoring, and control applications.

The Uni-Micro has 128 Kbytes of flash memory, 32 Kbytes of boot/data flash, 256 bytes RAM, a 2-Kbyte battery back-up scratchpad SRAM, 3,000 gates programmable logic, and 54 programmable I/O pins.

The Uni-Micro has 32 Kbytes of separate flash for boot and data storage, arranged in four sectors of 8 Kbytes each. The onboard boot/data flash enables concurrent main flash erase/write during program execution.

The Uni-Micro Module has 3,000 gates programmable logic with direct bus connection between the microcontroller core and the logic flip-flops. This programmable logic is sufficient to implement complex peripheral functions including mail boxes, keypad scanners, timers, counters, inter-



rupt controllers, shift registers, and others. The Uni-Micro sells for \$59.99. For more information, contact:

**OS SYSTEMS**  
2600 BENTLEY RD., #1806, DEPT. NV  
MARIETTA, GA 30067  
770-955-6101

E-MAIL: [ottoseg@ossystems.net](mailto:ottoseg@ossystems.net)  
<http://www.ossystems.net/unimicro1.html>



## SUPER ANTENNA MODEL 2

**G**odar Electronics introduces the Super Antenna Model 2, high definition TV antenna.

It is the world's first portable flat compact Yagi HDTV antenna. This Super Antenna is excellent for high-end FM applications (non-amplified noise free) reception. Broadband passive Yagi design for analog digital, VHF, UHF, FM stereo reception.

Model 2 was designed for placement on home theater wall units, and big screen TVs. It's also excellent for tight crawl spaces and attics (height is only 1"). Model 2 requires no mounting hardware.

The antenna is designed for apartment, condo tenants, and home owners where outdoor antenna installations are restricted.

Super Antenna Model 2 retails for \$69.95, available factory direct.

For more information, contact:

**GODAR ELECTRONICS CO.**  
339 N. GILBERT RD., DEPT. NV  
GILBERT, AZ 85234  
602-892-8207

**Showcase your New Products here! Send all press releases or information/photos to:**

**Nuts & Volts Magazine**  
**New Product News**  
430 Princeland Court,  
Corona, CA 91719  
or E-Mail to  
[newproducts@nutsvolts.com](mailto:newproducts@nutsvolts.com)

## SPECTRUM FOR WINDOWS

**A**llison Technology Corporation announces the release of the Window's version of Spectrum, its software program capable of performing advanced spectral analysis on incoming signals.

Spectrum runs under both Window's 3.1x 16 bit operating systems and under Window's 95/98 32 bit operating systems. It captures real-time data from the ATC O-Scope II module or from Pico Technology's ADC2xx virtual instruments.

Available modules offer frequency ranges of up to 50 MHz bandwidth and converter resolutions from 8 to 16 bits.

Spectrum for Windows sells for \$49.00 and includes drivers for the O-Scope II and the Pico Technology ADC2xx products.

The Spectrum software also includes Spectrum for DOS which comes with drivers for both the ATC O-Scope I and O-Scope II.

For more information, contact:

**ALLISON TECHNOLOGY CORP.**  
2006 FINNEY VALLET RD., DEPT. NV  
ROSENBERG, TX 77471  
1-800-980-9806  
281-239-8500 FAX: 281-239-8006  
E-MAIL: [atc@accesscomm.net](mailto:atc@accesscomm.net)  
WEB: <http://www.atcweb.com>

## VGA-801 MONITOR CONVERTER

**M**atco, Inc. introduces the VGA-801 PC monitor converter, an easy low-cost way of displaying B/W or standard NTSC/PAL color video directly on an existing VGA computer monitor.

This stand-alone device has RCA inputs for the composite video input and plugs directly into any VGA/SVGA monitor. With 24-bit 16.7 million true colors processing, it triples the resolution of a standard TV in black and white mode, and doubles the resolution in color mode. An audio amplifier is provided with a flat frequency response from 100 Hz to 31.5 KHz.

The VGA-801 can be configured to automatically switch from a VGA input if any external composite video signal is present. This is extremely useful, if you want to be aware of an alarm condition. An S-Video input connector is also provided.

Other features include its automatic NTSC and PAL conversion without the need of selecting the video source. Complete with five-volt regulated power supply. Overall dimensions are 4-1/2" x 2-1/2" x 3/4".



Customizations and private labeling are available.

The VGA-801 monitor converter is priced at \$69.00.

For more information, contact:

**MATCO, INC.**  
830 E. HIGGINS RD., #111-P, DEPT. NV  
SCHAUMBURG, IL 60173  
1-800-719-9605 FAX: 847-619-0852  
E-MAIL: [info@mat-co.com](mailto:info@mat-co.com)  
WEB: [www.mat-co.com](http://www.mat-co.com)

## NEW COMMUNICATIONS CATALOG

**U**niversal Radio announces its new 1999 Communications Catalog. Catalog #99-02 is 120 pages in 8-1/2 by 11 inch format.

It covers equipment for the amateur, shortwave, and scanner enthusiast.

An impressive selection of antennas, headphones, books, and accessories are also featured.

Several new items are premiering in this catalog: Sony ICF-SW07 portable receiver; ICOM IC-R75 communications receiver; ICOM PCR-100 wideband computer receiver; AOR AR7000B wideband communications receiver; Japan Radio Co. NRD-301A communications receiver; Grundig YB-300PE

portable receiver; Kenwood TH-D7A 2M/440 amateur handi-talkie; ICOM T81A 6M/2M/440/1.2 GHz amateur handi-talkie; plus many new antennas, accessories, and books.

This is their biggest catalog ever and is available free on request by fourth class mail or for \$3.00 by priority mail.

For more information, contact:

**UNIVERSAL RADIO, INC.**  
6830 AMERICANA PKWY., DEPT. NV  
REYNOLDSBURG, OH 43068-4113  
614-866-4267 FAX: 614-866-2339  
1-800-431-3939  
E-MAIL: [dx@universal-radio.com](mailto:dx@universal-radio.com)  
WEB: [www.universal-radio.com](http://www.universal-radio.com)



**Fantastic DMM Offer!**

Don't let this price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch. **Rubber Boot Included!**  
 Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity  
 Overrange Indication: 3 Least Significant Digits Blank  
 Temperature for Guaranteed Accuracy: 23°C  
 ±5°C RH<75%  
 Temperature Ranges:  
 Operating: 0°C to 40°C (32°F to 104°F)  
 Storage: -10°C to 50°C (14°F to 122°F)  
 Power: 9V Alkaline or Carbon-Zinc Battery (NEDA 1604)  
 Low Battery Indication: BAT on Left of LCD Display  
 Dimensions: 188mm(L) x 87mm(W) x 33mm thick  
 Net Weight: 400g **Get All the Specs From Our Web Site**



#9300G

**7 1/2" Pro Modular Crimping Tool Kit**

Includes:  
 • Heavy Duty Ratchet Crimp Tool  
 • 5 Die Sets!  
**#HT-330K**



**ONLY \$64.95**  
 Details on our Web Site

**True RMS DMM**

• Full Sized, 4 1/2 Digit  
 • Frequency Range to 20 KHz  
 • Capacitance Ranges from 2000 pF to 20 uF  
 • hfe, Audible Continuity, 20A max 1000VDC/20A max & 700VAC max  
 • Selectable Data Hold Function



**ONLY \$69**  
**CSI-980 DMM**

**Removable Hard Drive Rack**

For IDE/Ultra DMA Hard Drives

We Sold Over 14,000 in 1998!

This product can be used with any 3-1/2 IDE hard drive up to 1" high. It includes an electronic keylock for safe removal and insertion. Made of ABS 707 fireproof plastic. Use this product to protect sensitive hard drive data, take your hard drive between work and home or even set up different users with their own hard drives that they physically insert every time they use a PC. Other models available from C.S.I. include RH10 series and RH20 series, which are interchangeable within the same interface design (IDE or SCSI).

Other Models are Available. See [www.web-tronics.com](http://www.web-tronics.com) under "hard drive and accessories" for more details and pictures.

RH-10C-IDE

**ONLY \$14.95**

**Our Most Sophisticated DMM We Sold Over 700 Last Year!**

with RS-232 Interface &amp; Software, 3-3/4 Digit, 4000 Count.

Auto-Ranging with Analog Bargraph

• True RMS Mode  
 • 10MHz Frequency Counter  
 • Time Mode with Alarm, Clock, and Stop Watch  
 • Dual Display  
 • 10 Location Memory  
 • Min, Max, Avg and Relative Mode  
 • Decibel Measurement  
 • Cap and Ind. Measurement  
 • Temperature Mode (C/F)  
 • K Type Temperature Probe Included  
 • Pulse Signal for Logic &



• Audible Test  
 • Continuity/Diode Test  
 • Logic Test  
 • Auto Power OFF/Keep ON Mode  
 • Fused 20A Input with Warning Beeper  
 • Back Light  
 • Data Hold/Run Mode  
 • Safety Design UL1244 & VDE-0411  
 • Protective Holster  
 • Silicon Test Leads

PROTEK 506

**SALE \$139**  
 Reg. \$169

**Auto-Temp Solder Station with Ceramic Element**

• With Ceramic Heating Element for More Accurate Temp Adjustment  
 • 3 Conductor Grounded Power Cord  
 • 250°C-480°C (470°F-900°F)  
 • Fast Heating Feature

**ONLY \$39**  
**SR-976** Extra Tip Options Available. See Web!



CTRL - D to bookmark this site

**www.web-tronics.com**  
 Don't forget the dash **Circuit Specialists Inc.**

• Easy to Navigate  
 • Includes a Search Engine That Really Works  
 • New Items Added Constantly

In Business Since 1971

**CCD B&W Board Cameras**

• ASIC CCD Area Image Sensor  
 • Extremely Low Power Consumption  
 • 0.5 Lux Min Illumination  
 • Built-In Electronic Auto Iris for Auto Light Compensation  
 Detailed Specs on the Web



**VM1030PA**  
 Pinhole lens with audio, 30mmx30mmx25mm, 12V, 430 horz & vert TV lines  
**\$59.00 \$49.00**  
 5 or more



**VMCB21**  
 44mmx38.5mmx28mm with 6 infra-red LEDs, 12V, 380 horz TV lines  
**ON SALE \$59.00** any qty. Reg. \$69.00



**VM1035A**  
 42mmx42mmx25mm Standard lens with audio, 12V, 430 horz & vert TV lines with back light compensation  
**\$77.00 \$68.00**  
 5 or more



**VM1030A**  
 30mmx30mmx26mm Standard lens with audio, 12V, 430 horz & vert TV lines  
**\$59.00 \$49.00**  
 5 or more



**VM1036A**  
 32mmx32mmx25mm Standard lens with audio, 12V, 430 horz & vert TV lines, reverse mirror image feature  
**\$69.00 \$63.00**  
 5 or more

**COLOR CCD Mini Board Cameras**

• Low Power Consumption  
 • 1 Lux Illumination  
 • Built-In Electronic Auto Iris for Auto Light Compensation  
 • Internal Synchronization  
 • 12Volts  
 • 400 TV Lines



**VM3011-A**  
 45mmx40mmx24mm Standard lens with audio, single board  
**\$147.00 \$139.00**  
 5 or more



**VM3010PA**  
 33mmx33mmx18mm Pinhole lens with audio  
**\$149.00 \$137.00**  
 5 or more



**VM3010-A**  
 33mmx33mmx32mm Standard lens with audio  
**\$144.00 \$129.00**  
 5 or more

Detailed Specs on the Web

**Bullet CCD Cameras B&W and Color**

• Smart Rugged Metal Housing  
 • Extremely Low Power Consumption  
 • 12 Volt  
 • CCD Area Image Sensor for Long Camera Life  
 • Built-In Electronic Auto Iris for Auto Light Compensation  
 • No Blooming, No Burning  
 • 0.1 Min Lux Illumination (B&W), 1 Lux Min Lux Illumination (color)



**VMBLT3025W**  
 Digital Color, Weatherproof 20mm(D)x83mm(L)  
**\$219.00 \$199.00**  
 5 or more



**VMBLT1020W**  
 B&W Weatherproof 21mm(D)x58.5mm(L)  
**\$96.00 \$89.00**  
 5 or more



**VMBLT1020A**  
 B&W with audio 21mm(D)x55mm(L)  
**\$85.95 \$77.00**  
 5 or more

Detailed Specs on the Web

**Protek Amazing Test Equipment Offers**

Series 6500 Deluxe  
 20MHz/40MHz/60MHz/100MHz  
 Dual-Trace Oscilloscopes

• Alternate Trigger  
 • Internal Sync Separator Circuit  
 • Alt-Mag Sweep  
 • Delay Sweep (6510)

LATEST DESIGNS!

Asia's currencies are devalued against U.S. dollars. Take advantage of **GREAT** prices while they last!



**#6502 - 20MHz**  
**\$289**

**#6504 - 40MHz**  
**\$569**

**#6506 - 60MHz**  
**\$689**

**#6510 - 100MHz**  
**\$799**

These deluxe HC Protek oscilloscopes provide the features and accuracy that serious technicians and engineers need at prices well below what you may have expected. These dual-trace, dual-channel scopes have Alt-Mag sweeps and provide simultaneous display of normal and magnified traces. An internal sync separator circuit provides stable triggering of video signals. TV-H (TV line synchronizing feature) and TV-V (TV frame synchronizing frequency) are automatically switched by the Time/Div front-panel control. The user can view parallax-free waveform measurements on the large 6" rectangular CRT that includes an illuminated internal 8x10 Div graticule.

Part No.	6510	6506	6504	6502
Bandwidth	100MHz	60MHz	40MHz	20MHz
Vert. Sensitivity	1mV/Div to 5V/Div	1mV/Div to 5V/Div	1mV/Div to 5V/Div	1mV/Div to 5V/Div
Max Sweep Rate	2nS/Div to 0.2S/Div	0.1uS/Div to 0.2S/Div	0.1uS/Div to 0.2S/Div	0.2uS/Div to 0.5S/Div
Delay Sweep	YES	YES	YES	YES
Vert. Mode Trig.	YES	YES	YES	YES
Cursor Readout	NO	NO	NO	NO
CRT Volts	12KV	10KV	10KV	2KV

For More Information See [www.web-tronics.com](http://www.web-tronics.com)**Amazing Test Equipment Offers****10MHz Pulse Generator**

• Max. 10MHz Rate  
 • Adjustable Delay Time & Pulse Width  
 • External Oscillator Input  
 • Variable Output Level Control  
 • Delay Function  
 • Frequency Counter



**B1010**  
**\$269**

See the web site for details

**2GHz Universal Counter**

• Frequency, Period, Totalize Ratio Measurements  
 • Low Pass Filter  
 • 3 Channel Input (CH A, CH B, CH C)  
 • Variable Trigger Level  
 • 8 Digit LED Display  
 • 4 Step Gate Time Control  
 • FI/IO Input Attenuator  
 • Self Test



**U2000A**  
**\$319**

See the web site for details

**1GHz Multifunction Counter**

• Frequency, Period, Totalize Measurements  
 • Low Pass Filter  
 • 2 Channel Input (100MHz, 1GHz)  
 • 8 Digit Gate Time Control  
 • 1/20 Input Attenuator



**B-818**  
**\$209**

See the web site for details

**Digital Multimeter**

• AC/DC Voltage, AC/DC Current, Resistance Measurement  
 • 4 1/2 Digit Display  
 • Over Range Indication  
 • 7 Functions  
 • Data Hold Function



**9902A**  
**\$189**

See the web site for details

**10MHz Sweep Function Generator**

• Sine, Triangle, Square, Ramp, Pulse Waveform  
 • Gate & Trigger Output  
 • Burst Waveform Output  
 • Sweep Function (Linear/Logarithmic)  
 • VCG Input  
 • GCV Function  
 • AM Modulation  
 • Variable Symmetry  
 • Output Attenuator  
 • DC Offset  
 • Frequency Counter



**B-810**  
**\$559**

See the web site for details

**2MHz Sweep Function Generator**

• Sweep Function Width: 1:1 to 1000:1  
 • Sweep Rate: 0.5Hz to 50Hz  
 • Attenuation: -20dB  
 • Frequency Range: 0.02Hz to 2MHz in 7 Ranges  
 • Outputs: Sine, Triangle, Square Wave, Pulse, Ramp, Slew Sine Wave  
 • Sync Out: TTL Square Wave



**9205**  
**\$219**

See the web site for details

**2MHz Sweep Function Generator**

• Sine, Triangle, Square, Pulse, Ramp, Slew Sine Waveform  
 • Sync. Output (TTL Square Waveform)  
 • Sweep Function  
 • VCG Input  
 • DC Offset  
 • Variable Symmetry



**9205C**  
**\$279**

See the web site for details

**20 Amp Switching Power Supply With Overvoltage Protection and Variable DC Output**

**Specifications**  
 Input Voltage: AC 110V ±15%, 50Hz/60Hz  
 Output Voltage: DC 9V - 15V variable  
 Polarity: Negative ground  
 Current (13.8V): 25A peak, 20A continuous  
 Overvoltage Protection  
 Cooling fan inside chassis  
 See the web site for details



**\$99**  
**#SPS-1020G**

**PC Based Digital Storage Oscilloscope**

With Easy to Use Software  
 • Auto Setup  
 • Pre Trigger  
 • Voltage Range: 50mV to 5V, 7 steps  
 • Time Range: 50ns/div to 0.5s/div, 1-2.5 22 steps  
 • 32KB, Memory Depth



#220

**ONLY \$199**

See the web site for details

**HDD Heat Sink & Fan Heat Reduction System**

• The Ultimate Heat Reduction System for Hard Drives  
 • Huge Aluminum Heat Sink, Plus Two Cooling Fans  
 • Heat Terminator Mounts in Any 5.25" F.D.D. Bay  
 • For All 3.5 Drives up to 1" High  
 • Hard Drive Heat Reduction up to 33%

**HEAT TERMINATOR**  
**\$39.00 \$35.00**  
 10 or more

See the web site for details

**2GHz RF Field Strength Analyzer**

• Frequency Range: 100KHz to 2,060MHz  
 • Narrow Band FM (NFM), Wide Band FM (WFM), AM and Single Side Band (SSB) Modulated Signals May Be Measured  
 • PLL Tuning System for Precise Frequency Measurement and Tuning  
 • LED Backlight LCD (192x192 dots)



**#3201**

See the web site for details

• Built-In Frequency Counter  
 • Hand-Held and Battery Operated  
 • All Functions are Menu Selected  
 • RS232C for PC Interface and Printer

**ONLY \$1529**

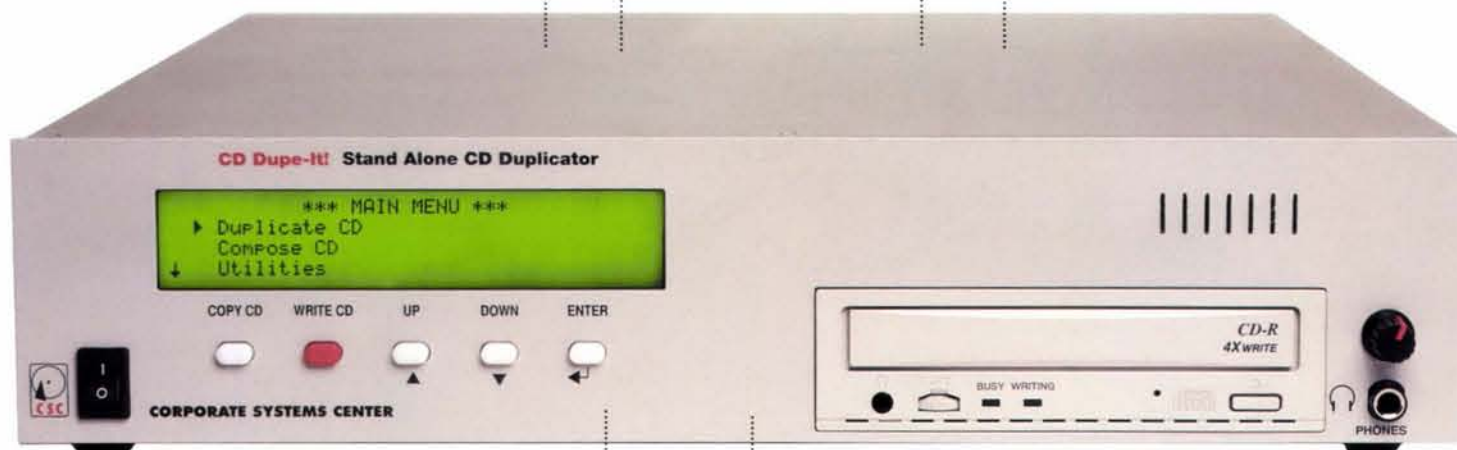


**BOTH SINGLE AND DUAL  
DRIVE MODELS AVAILABLE.**

**INTERNAL A/V HARD DRIVE  
STORES DISC IMAGES FOR MULTIPLE  
COPIES, AND CUSTOM AUDIO DISCS.**

**EXTERNAL SCSI-II PORT WORKS  
LIKE A STANDARD CD WRITER  
FOR CREATING CUSTOM DISCS.**

**MAKE CUSTOM DISCS WITH  
JUST THE MUSIC YOU LIKE.**



**TOTALLY SELF CONTAINED,  
NO ADDITIONAL HARDWARE  
IS REQUIRED**

**ADVANCED FORMAT DETECTION  
PRODUCES PERFECT DUPLICATES  
ON STANDARD CD-R MEDIA.**

# COPY ANY CD NOW. NO PC REQUIRED.

## DUPE-IT!

Instantly copy music and CD-ROM compact discs. Make backup copies of your favorite music and software on rugged, permanent CDs. Produce compact discs quickly and economically. No mastering or multimedia experience is required.

Insert your original CD and press "start." The multimedia processor quickly copies any disc to the internal A/V hard drive. Insert blank CDs and make as many copies as you like. You'll produce perfect duplicates. The system is totally self contained — no additional hardware is required.

**BUY DIRECT: FROM \$795!  
100 BLANK CDs \$169!  
408 330-5524**

Just plug in the power cord and press "start"—it's that easy.

You can even make your own custom music CD without a PC! Insert your original CD's, select the tracks you want, and Dupe-It will copy them to the internal hard drive. Then insert a blank CD, and you'll have a custom music CD with just the songs you want.

With the included CD mastering software, Dupe-It will work over-time as your personal CD design system. Just attach a SCSI cable

to your PC or Mac, and you're ready to design and create your own original CD's. Similar systems used in duplication houses cost over \$5,000. Now you can easily copy CDs yourself for a fraction of the price.



**CORPORATE SYSTEMS CENTER**  
3310 WOODWARD AVE., SANTA CLARA, CA 95054  
[WWW.DUPEIT.COM](http://WWW.DUPEIT.COM)

Musicians—ask about our pro-audio CD recorders. Software publishers—ask about our high-volume multi-drive duplication systems. Dupe-It is sold and intended for backup and in-house design purposes only. Copyright laws must be observed.



# BAG THE BASICS

## BAG the BASICS is back!

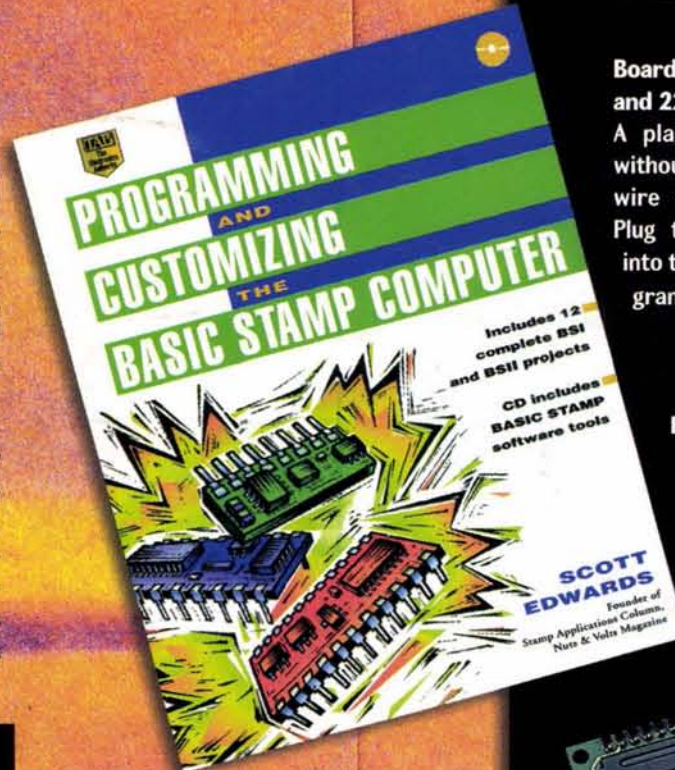
And this summer we've sweetened the deal.  
For \$159 you'll receive some of Parallax's best.

For \$159 you'll be equipped with the best BASIC Stamp products available. Last summer we introduced the original BASIC Stamp Rev. D. with "Bag the BASICS", and this summer we've improved the package with the BASIC Stamp II, the new Board of Education, the Scott Edwards' "Programming and Customizing the BASIC Stamp" book, and a 2 x 16 Serial LCD module. This is the finest set of BASIC Stamp hardware available for those getting started.

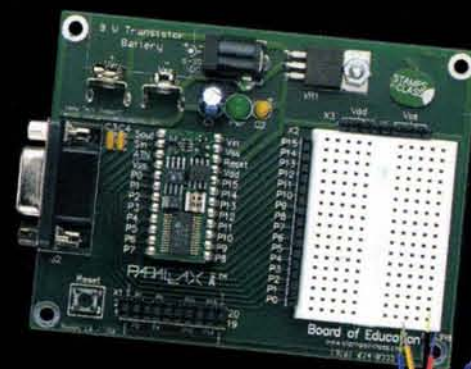
Programming & Customizing the BASIC Stamp Computer by Scott Edwards: This BASIC Stamp primer teaches you the essentials of PBASIC programming and basic electronics. The book presents ten complete projects, a CD-ROM containing the Parallax BASIC Stamp Manual Version 1.9, software and 20+ application notes, and 30 Stamp applications columns from Nuts & Volts magazine. No shortage of ideas here.

**Order the BAG the BASICS 2 Bundle (#27802) for \$159. A savings of \$49!**

Please don't ask us to extend Bag the BASICS beyond July 31, 1999. It's only here as an incentive for your summertime projects.



**BASIC Stamp II Module:**  
The most popular BASIC Stamp ever made. 16 I/O line and up to 500 lines of PBASIC source code. Serial PC interface.



**Board of Education and 22 gauge wires:**  
A place to build projects without the headaches of wire wrap or solder. Plug the components into the board and program your BASIC Stamp.

**Programming & Customizing the BASIC Stamp Computer by Scott Edwards:** Your guide to the BASIC Stamp and PBASIC.



**2 x 16 Serial LCD:** This widely used serial LCD lets the BASIC Stamp display characters and variables with only one line of PBASIC code. Plug it into the side of your Board of Education.

**PARALLAX**

visit us online [www.parallaxinc.com](http://www.parallaxinc.com)

Write in 194 on Reader Service Card.

**NUTS & VOLTS MAGAZINE**  
430 PRINCELAND COURT  
CORONA, CA 91719

CHANGE SERVICE REQUESTED

BULK RATE  
U.S. POSTAGE  
**PAID**  
PERMIT No. 49  
LONG BEACH CA

